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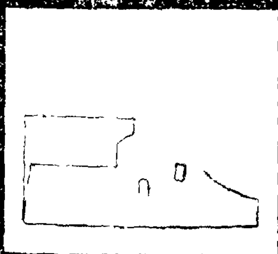
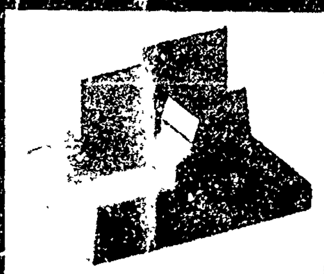
ENGINEERING (CASE) PROJECT

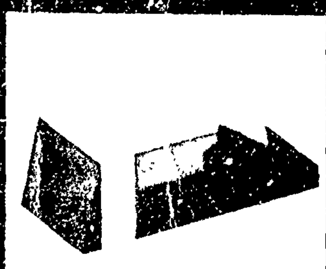
INSTRUCTION REPORT ITL-87-3

USER'S GUIDE: A THREE-DIMENSIONAL STABILITY ANALYSIS/DESIGN PROGRAM (3DSAD)

Report 2
GENERAL LOADS MODULE







by

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...rogram 3DSAD does an overturning and sliding stability analysis for complex th... ...l structures. Specific structure types and general shapes can be handled. General ... are: geometry--to define, display, and compute mass properties; loads--to define, display, and compute loads; analysis--to perform a base analysis assuming a rigid body on an elastic foundation; and free-body--to use clipping capability for a free-body analysis.

Geometry is defined by two-dimensional cross sections swept or grown linearly or axisymmetrically in the third dimension, eight-node brick finite elements, and clusters of planar faces and bicubic patches.

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19. ABSTRACT (Continued).

Loads are computed by giving a direction to a volume defined in the General Geometry Module format, specifying a point load, and simplifying load commands wherever soil and water levels are specified. Geometry and loads may be displayed by color wire-frame, hidden line, or continuous tone plots, and load cases may be defined.

Keywords: Army Corps of Engineers, CASE (Computer Aided Structural Engineering),

PREFACE

This report documents the General Loads Module of the Three-Dimensional (3-D) Stability Analysis/Design (3DSAD) Program. The module was developed and this report was written at the US Army Engineer Waterways Experiment Station (WES), Information Technology Laboratory (ITL), by Mr. Fred T. Tracy, Interdisciplinary Research Group, Computer-Aided Engineering Division (CAED), and Ms. Mary Ann Leggett, Ph.D., Belhaven College, Jackson, MS, under the Intergovernmental Personnel Act. The work was sponsored through funds provided WES by the Engineering and Construction Directorate, Headquarters, US Army Corps of Engineers (HQUSACE), under the Computer-Aided Structural Engineering (CASE) Project. Specifications for the program were provided by the members of the CASE Task Group on 3-D Stability. The members of the task group during the initial period of development were as follows:

Mr. Charles Kling, US Army Engineer District, Mobile (Chairman)
Mr. Robert Haavisto, US Army Engineer District, Sacramento
Mr. John Hoffmeister, US Army Engineer District, Nashville
Mr. Gerrett Johnson, US Army Engineer District, Seattle
Mr. Thomas Mudd, US Army Engineer District, St. Louis
Mr. William Holtham, US Army Engineer Division, New England

Members of the task group during the latest development were:

Mr. Kling (Chairman)
Mr. Lavane Dempsey, US Army Engineer District, St. Paul
Mr. Bob Boschert, US Army Engineer District, Sacramento
Mr. Holtham
Mr. Johnson
Mr. Tom Leicht, US Army Engineer District, St. Louis

Mr. Donald R. Dressler and Mr. Tony Liu, Structures Branch, Engineering and Construction Directorate, were the HQUSACE points of contact. The work was accomplished at WES under the supervision of Dr. N. Radhakrishnan, Chief, ITL, Mr. Paul Senter, Assistant Chief, ITL, and Dr. Ed Middleton, Chief, CAED. The work was coordinated by Mr. Senter, former CASE Program Manager, and Mr. H. Wayne Jones, CASE Program Manager and Chief, Scientific and Engineering Applications Center, CAED. The report was edited for publication by Ms. Gilda Miller, Information Products Division, ITL.

Wherever references to the following operating systems are made throughout the text of this report, it should be noted that MS-DOS is a registered

trademark of Microsoft, Inc., UNIX is a trademark of AT&T, and Intergraph engineering workstations are a product of Intergraph Corporation.

Commander and Director of WES during this study was COL Larry B. Fulton, EN. Technical Director was Dr. Robert W. Whalin.

CONTENTS

USER'S GUIDE: A THREE-DIMENSIONAL STABILITY ANALYSIS/DESIGN PROGRAM (3DSAD)

GENERAL LOADS MODULE

PART I: OVERVIEW OF THE THREE-DIMENSIONAL STABILITY PROGRAM

Objective

1. The objective of the Computer-Aided Structural Engineering (CASE) Task Group on Three-Dimensional (3-D) Stability Analysis is to develop computer programs to aid design engineers in performing stability computations for general 3-D structures (Tracy 1980; Tracy and Kling 1982; Tracy, Kling, and Holtham 1983; Tracy 1986; Tracy 1987a; and Tracy 1987b). To enable this, a computer program entitled 3DSAD (3-D stability analysis/design) has been developed in a modular fashion. Currently, 3DSAD has four "general" modules:

a. General Geometry Module.

(1) Defines geometry based on two-dimensional (2-D) cross sections extended into the third dimension, eight-node brick elements, or clusters of planar polygons or bicubic patches.

(2) Performs centroid, volume, and weight computations on described geometry.

(3) Employs interactive graphics extensively.

b. General Loads Module.

(1) Computes forces and moments for the defined loads on a general 3-D structure.

(2) Uses all the capabilities of the General Geometry Module to define and display loads as "pressure volumes."

(3) Defines loads as point loads.

(4) Begins with a description of soil and water levels and applies "simplified loads commands" (PC and Intergraph Engineering Workstations only) to define the loads.

(5) Allows the definition of different load cases.

c. General Analysis Module. This module performs overturning, bearing, and sliding computations for any planar or near planar base.

d. Free-Body Module. This module "clips" the structure and loads by an arbitrary plane to produce a "free body" so that computations can be performed on the new part.

The engineer performing an analysis of any 3-D structure can interact directly with these modules.

2. In addition to the general capabilities that are useful for any 3-D structure, 3DSAD also provides for simplified geometry and load input along with criteria check modules for certain structure types. This latter capability will permit interactive design of these structures. Examples of specific structure types for which modules have been or are being developed are dams, gravity locks, U-frame locks, and intake structure towers.

3. A specific structure input module requires less data than that for a general structure. Modules of this type will interact with the General Geometry Module and the General Loads Module to define the geometry and loads internally in the program. After analysis, a specific structure criteria check module will verify pertinent values, change dimensions (if necessary), and cycle through the computations. A schematic of this part of the 3DSAD program is shown in Figure 1.

4. The 3DSAD program has been developed in phases. During the first phase, the first three general modules were developed. This approach enabled

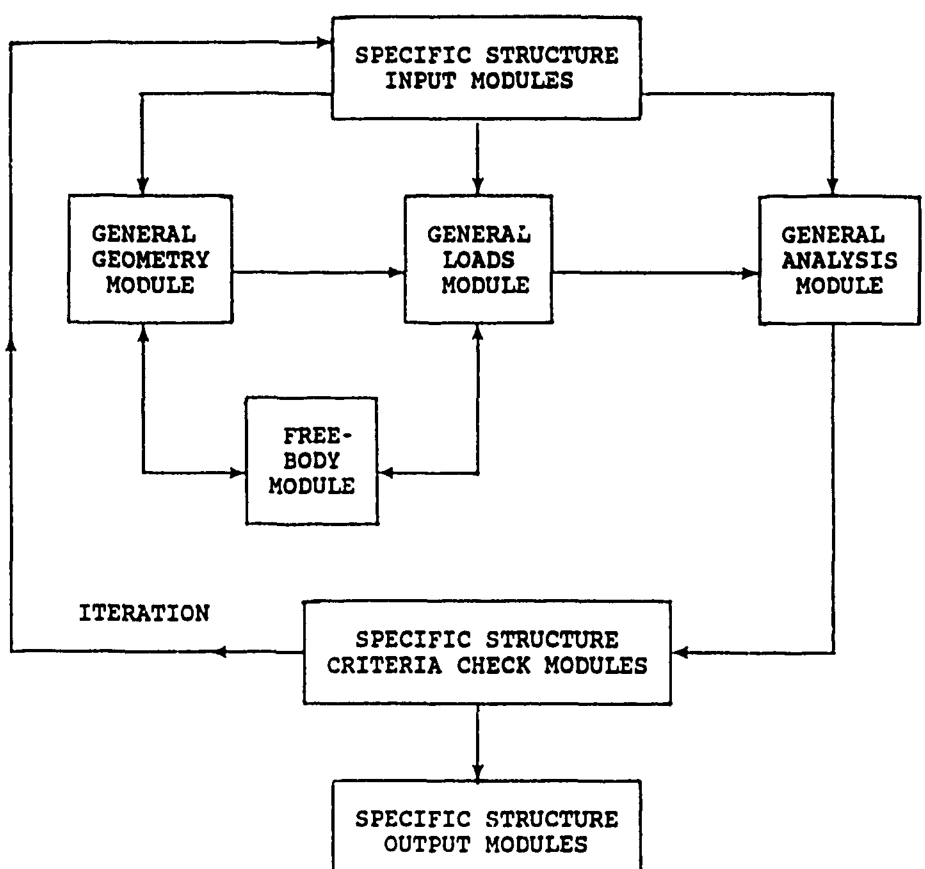


Figure 1. General schematic of 3DSAD

the stability analysis of any 3-D structure, although the input is more complicated than need be for certain structures. In the subsequent phases, the special input and criteria check modules were developed for specific structures. New general modules, such as the Free-Body Module, and enhancements to existing modules have been completed.

The General Loads Module

5. This report is a user's guide for the General Loads Module. The strategy for system development was to increase in level of complexity, therefore this module is a more recent development than the General Geometry and General Analysis Modules. Some capabilities such as definition of pressure volumes (paragraph 6) and wire-frame plots are available on all systems described in the computer information insert, whereas advanced tools such as simplified loads commands (paragraph 6) and shaded or hidden line plots with color are available only on PC's (MS-DOS) and Intergraph Engineering Workstations (UNIX). The documentation will flag those commands that have limited availability.

Loads Defined

6. Loads can be defined in three different ways: pressure volumes, point loads, and simplified load commands. Pressure volumes are generated using the same geometry building commands (BLOCK, BRICK, FACE, etc.) that are used in the General Geometry Module, except that now each volume has a direction of +X, -X, +Y, -Y, +Z. or -Z associated with it. The magnitude of the resulting force from a pressure volume is computed by multiplying the specified density by the computed volume, and the direction of this force is the specified direction. The moment is computed by applying the computed force at the centroid of the pressure volume, and then the moment is computed about the global axes. To illustrate, consider the example of a nonoverflow cross section shown in Figure 2 with the data used to generate it:

```
 10 POINTS    14
 20      1        0.          32.000      268.000
 30      2         1.500      32.000      283.000
 40      3       11.700       32.000      283.000
 50      4       11.700       32.000      283.000
 60      5       11.700       32.000      295.000
 70      6       17.700       32.000      305.000
 80      7       17.700       32.000      315.000
 90      8       48.700       32.000      315.000
100      9       48.700       32.000      305.000
110     10       51.700       32.000      295.000
120     11       51.700       32.000      285.000
130     12       59.700       32.000      275.000
140     13       65.700       32.000      275.000
150     14       65.700       32.000      268.000
160 BLOCK NON1      0.15000       10.000      0
170          1.000        1.000
180   14 1 2 3 4 5 6 7 8 9 10 11 12 13 14
```

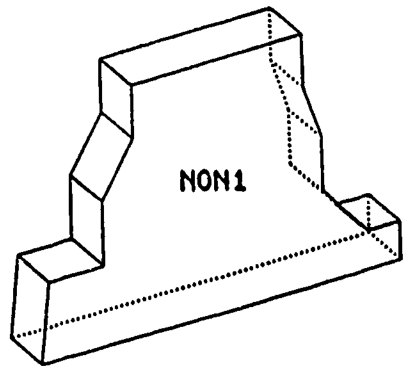


Figure 2. Nonoverflow cross section

If water is applied at 300 ft (91.44 m), this load can be represented by the two pressure volumes shown in Figure 3, the combined geometry and loads plots are shown in Figure 4, and defined by the following data:

```
 10 XZ
 20 POINTS     7
 30      1      0.          32.000      268.000
 40      2       1.500      32.000      283.000
 50      3      11.700      32.000      283.000
 60      4      11.700      32.000      283.000
 70      5      11.700      32.000      295.000
 80      6      14.700      32.000      300.000
 90      7      0.          32.000      300.000
100 BLOCK  -Z  V211     0.06250      10.000
110          1.000        1.000
120      7      7     6     5     4     3     2     1
130 POINTS     3
140      8     -10.000      32.000      300.000
150      9     -10.000      32.000      268.000
160     10     -16.400      32.000      268.000
170 BLOCK  +X  WH11     0.31250      10.000
180          1.000        1.000
190      3      8     9    10
```

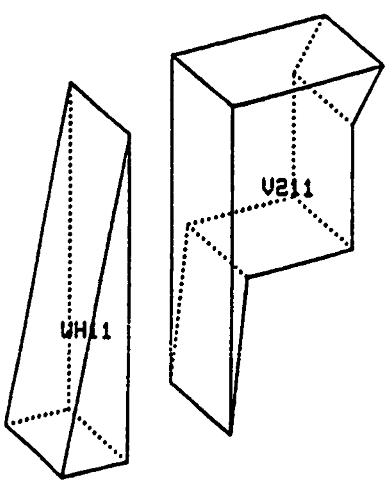


Figure 3. Pressure volumes

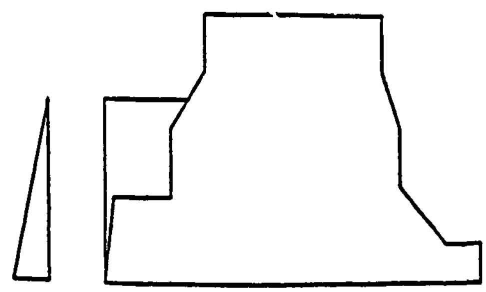


Figure 4. Combined geometry and load plots

One pressure volume represents the horizontal water load (WH11), and the other represents the vertical water load (V211).

7. After the user has created his geometry and loads data files, he can then input them into the General Loads Module, plot them, and give the FORCE ALL command to produce a detailed list of forces and moments as shown:

NAME	FX MX	FY MY	FZ MZ
V211	0. -5033.16	0. 790.28	-136.03 0.
WH11	320.00 0.	0. 89173.34	0. -11840.00
TOTAL	320.00 -5033.16	0. 89963.61	-136.03 -11840.00

These commands are described in detail in Part II.

8. A point load is simply a force expressed in x, y, and z components and specified at a point. The weight of the structure, for instance, can easily be expressed as a point load in the -Z direction placed at the centroid of the structure. Other point loads such as those generated in EARTHQUAKE computations (described in paragraph 56) are also used.

9. Simplified loads are a means of replacing the pressure volumes with less data when possible. For example, a WATER command giving the elevation of water and a LOAD command giving where the water acts might be simpler. The data file of simplified loads for the problem in Figure 2 is:

```
10 WATER HEAD 300
20 LOAD BLOCK NON1 SIDE 1 7 HEAD
```

These will also be described in detail later. Clearly, this is a substantial reduction in data.

10. Forces and moments can be obtained for the simplified loads commands by giving the SLOADS ALL command. The result is:

NAME	FX MX	FY MY	FZ MZ
HEAD-NON1	320.00 -5033.16	0. 89963.61	-136.03 -11840.00
TOTAL	320.00 -5033.16	0. 89963.61	-136.03 -11840.00

Coordinate System

11. The coordinate system used is shown in Figure 5. In this right-handed system, x is to the right, y is into the paper, and z is up.

Figure 5. Coordinate system

PART II: RUNNING THE PROGRAM

Getting Started

12. The user first initiates 3DSAD on his system (details in Specific System Information insert). After initialization, a set of questions are asked and will now be discussed.

STRUCTURE TYPE OR GENERAL MODULE ?

13. If the user types a "?", the following message will appear:

A THREE-DIMENSIONAL STABILITY ANALYSIS/DESIGN PROGRAM
(3DSAD)

A PRODUCT OF

Computer-Aided Design (CAD) OF STRUCTURAL STABILITY

() () () () () ()

```
ENTER ?, HELD, OR WHAT TO GET VALID RESPONSES.
ENTER STOP, END, QUIT, OR DONE TO TERMINATE PROGRAM.
STRUCTURE TYPE OR GENERAL MODULE ?
```

The user then issues

LOAD

for the General Loads Module.

14. The next question the program asks is

RESTART FILE NAME OR CR?

when "CR" stands for carriage return. This restart file saves all data pertaining to building structure geometry or loads, including any data input from another data file. A carriage return is given if the user does not want to save this file.

15. The next question is

OUTPUT FILE NAME OR CR?

The resulting forces and moments from a load case command are placed in this file. A carriage return is given if no output is to be saved, and thus any output from the CASE command is placed in a temporary scratch file.

16. The third question is

COMMAND?

A detailed description of each command, listed in Appendix A, is given in the following section.

Commands

17. The program uses commands (PLOT, FORCE, etc.) to both build and plot the input data and then compute the resulting forces and moments. The commands are:

a. Data building:

XZ XY YZ RTZ
POINT
CIRCLE ELLIPSE
QUADRATIC
BLOCK FACE
BR8
TRANSLATE
ROTD COPY REFLECT

b. Utility:

INPUT FORCE
END GO RETURN
CLIP CLEAR
PTLD QUAKE UPLIFT
CASE

c. Plotting:

PLOT WINDOW ZOOM
ROTP ISOMETRIC
LABEL NOLABEL
DASH HIDE SOLID COLOR
ERASE INITIALIZE
SHADED SHOWLOAD
BACKGROUND

d. Simplified loads:

DENSW WATER SOIL
LOAD SLOAD

This list is obtained by typing "?" at the command level. Commands and their accompanying data can be put into a data file or typed interactively while running the program. A beginning command sequence is:

INPUT FILENAME   Read data from file FILENAME.

- -

PLOT   Plot data.

FORCE   Compute and print pressure volume and point loads.

- -

<u>OR</u>

- -

SHOWLOAD   Display the given simplified load.

SLOAD   Compute and print simplified loads.

- -

END   End.

18. In giving the format for the commands, actual letters to be typed will be enclosed in the quotes to distinguish them from variable names. These quotes should not be typed when the user issues the command. Only the minimum number of letters of a command need to be given; however, the user can type the entire word. Required letters are shown in capitals, and optional letters are shown in lower case. When some commands are given, additional information will also be required. If the command is given interactively, questions concerning additional information will be asked. In the data file mode, this additional information must be put on the next line. Data placed into a data file must be preceded with line numbers and a space, whereas data given in the interactive mode do not need line numbers.

<u>"XZ", "XY", "YZ"</u>

19. As shown in the following tabulation, each of these commands turn on a flag to indicate that all "CIrcle" and "ELlipse" commands define circular and elliptical arcs in a particular plane, and all "BLock" commands start with cross sections in that plane and grow in the third direction.

Command	Defining Plane	Third Direction
"XZ"	x-z	y
"XY"	x-y	z
"YZ"	y-z	x

The specified command remains in effect until one of the others is given, or an "RTz" command is encountered. "XZ" is the default condition. Data files and plots given in Figures 2 and 3 demonstrate the use of these commands.

"RTz"

20. This command establishes a local polar coordinate system (radius-theta-z) in space. The z axis is established by two specified points (X1, Y1, Z1) and (X2, Y2, Z2), where (X1, Y1, Z1) is the new origin. The format of this command is

"RTz" X1 Y1 Z1 X2 Y2 Z2

Theta is zero in the r-theta plane where the new local z axis strikes the r-theta plane when projected vertically. If the new local z axis is vertical, theta is zero along the line parallel to the x axis and passing through (X1, Y1, Z1). All coordinates of points are specified in this system until another coordinate system is specified. "RTz" is in effect until the "XY", "XZ", or "YZ" command is given.

21. Any "BLock" commands given after an "RTz" command expect an angle in degrees to produce a volume swept by a rotation rather than a translation. The cross section for a block can have curved or straight line segments as before, but the points defining the cross section must have the same theta value. Figure 6 shows a sample data file with its plot. (Note: all data building commands will be illustrated in the data file mode, and others will be demonstrated in interactive mode.)

```
10 RTZ 6 5 0 6 5 1
20 POINTS 4
30 1 10 30 2
40 2 10 30 10
50 3 15 30 10
60 4 15 30 2
70 BLOCK -Z BL1 .1 90
80 1 1
90 4 1 2 3 4
```

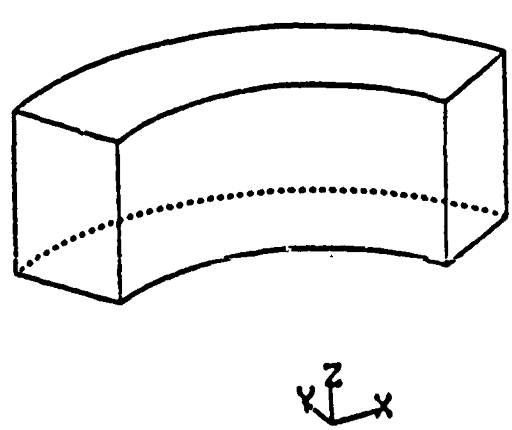


Figure 6. "RTz" example

"POints"

22. The user defines coordinates using the "POints" command that has the following format:

"POints" NPT

where NPT is the number of points. After this line, an identification number and x, y, z coordinates for each point are given as shown in the following example:

```
10 POINTS 14
20 1 0 0 565
30 2 44 0 565
40 3 44 0 577
50 4 40 0 577
60 5 40 0 597
70 6 22 0 617
80 7 22 0 633
90 8 4 0 633
100 9 4 0 577
110 10 0 0 577
120 11 9 0 585
130 12 9 0 595
140 13 19 0 595
150 14 19 0 585
```

"CIrcle"

23. Line segments between points are assumed straight unless otherwise specified, therefore the user must define any curved line segments. One common option is the circular arc. The possible ways of using the "CIrcle" command are:

```
"CIrcle" N1 N2 R
"CIrcle" N1 N2 R "Left"
"CIrcle" N1 N2 R "Right"
```

N1 and N2 are two point numbers connected by a circular arc of radius R. "Left" or "Right" designates on which side of the line segment N1 and N2 the center of the circle occurs. To correctly decide if the center of the circle is left or right of the line segment, the user must be looking in the counter-clockwise positive direction (-Y for "XZ", -Z for "XY", -X for "YZ", and -T for "RTz"). Figure 7 gives the data file and the resulting plot.

24. The "CIrcle" command is defined in one of the principal planes, depending on whether or not "XY", "XZ", "YZ", or "RTZ" has been previously given.

"ELlipse"

25. The user can also use elliptical segments to define curved line segments. The different versions of the "ELlipse" command are:

```
"ELlipse" N1 N2 A B
"ELlipse" N1 N2 A B "Left"
"ELlipse" N1 N2 A B "Right"
```

```
10 XZ
20 POINTS 4
30 1 0 0 -5
40 2 5 0 0
50 3 0 0 5
60 4 -5 0 0
70 CIRC 2 1 5
80 CIRC 3 2 5 LEFT
90 CIRC 3 4 5 RIGHT
100 CIRC 1 4 5
```

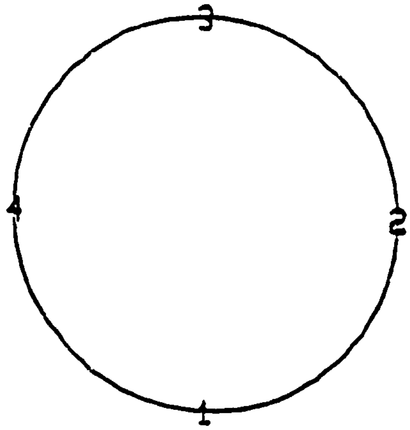


Figure 7. "CIrcle" command

N1 and N2 are two point numbers connected by an elliptical arc having semimajor axis length A and semiminor axis length B. "Left" and "Right" have the same meaning as in the "CIrcle" command. The data file and resulting plot are shown in Figure 8. The semimajor and semiminor axes are always parallel to the coordinate axes.

```
10 XZ
20 POINTS 4
30 1 0 0 -5
40 2 10 0 0
50 3 0 0 5
60 4 -10 0 0
70 ELLI 2 1 10 5
80 ELLI 3 2 10 5 LEFT
90 ELLI 3 4 10 5 RIGHT
100 ELLI 1 4 10 5
```

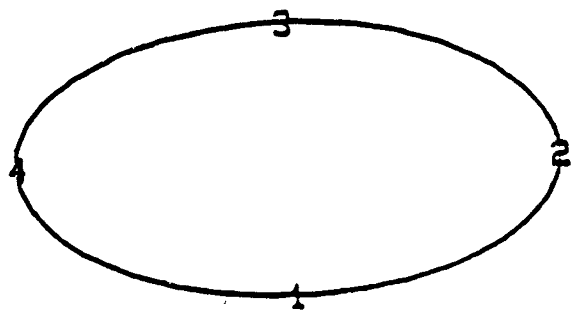


Figure 8. "ELlipse" command

26. As with the "CIrcle" command, the "ELlipse" command will be defined in one of the principal planes, depending on whether or not "XY", "XZ", "YZ", or "RTz" has been previously given. The "ROTD" command can then be used to rotate the elliptical arc to a general orientation in space.

"Quadratic"

27. The quadratic line segment is provided for cases when the user needs a curved line segment that is not circular or elliptical. The command format is

"Quadratic" N1 N2 XQQ YQQ ZQQ

where N1 and N2 are the point numbers between which the quadratic line segment is to be drawn, and (XQQ, YQQ, ZQQ) is an interpolation point (Figure 9) that the curve must go through. The data file and resulting plot are shown in Figure 10. When "RTz" has been specified, XQQ, YQQ, and ZQQ become RQQ, TQQ, and ZQQ in the local polar coordinate system.

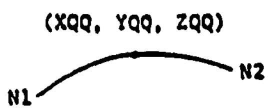


Figure 9. Quadratic plotting

```
10 XZ
20 POINTS 4
30 1 0 0 -5
40 2 5 0 0
50 3 0 0 5
60 4 -5 0 0
70 QUAD 1 2 4 0 -3
80 QUAD 2 3 3 0 4
90 QUAD 3 4 -4 0 3
100 QUAD 4 1 -3 0 -4
```

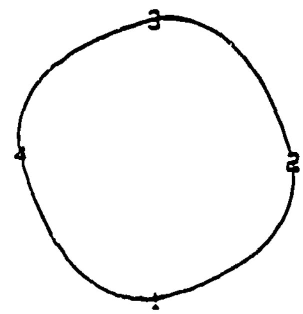


Figure 10. "Quadratic" command

"BLock"

28. Perhaps the most useful way to define geometry or loads is the "BLock" command. A 2-D cross section defined in one of the principal planes (x-y, x-z, y-z, or local r-z) is allowed to grow or be swept in the third (perpendicular) direction. The format for this command is

"BLock" DIR NAME DENS DEPTH NHOLE

where

DIR - direction (X, +X, -X, Y, +Y, -Y, Z, +Z, -Z) of the force produced by the pressure-volume (or left blank if the block represents geometry)

NAME - four-character name of the block

DENS - density

DEPTH - how far the cross section is extended

NHOLE = number of holes in the cross section

After the "BLock" command is given, the following questions are then asked for the outer boundary and each hole:

```
SFX, SFZ, XAPEX, ZAPEX, HFX, HFZ ?
CONNECTIVITY DATA ?
```

To understand these questions and the "BLock" command, consider the following example. The 14 points in Figure 11 have been read in by the "POints" command. The number of points followed by the point labels given in

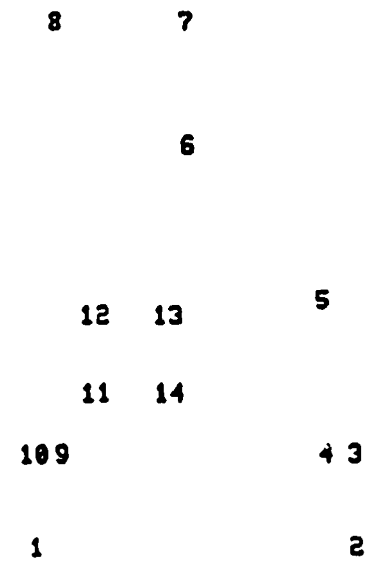
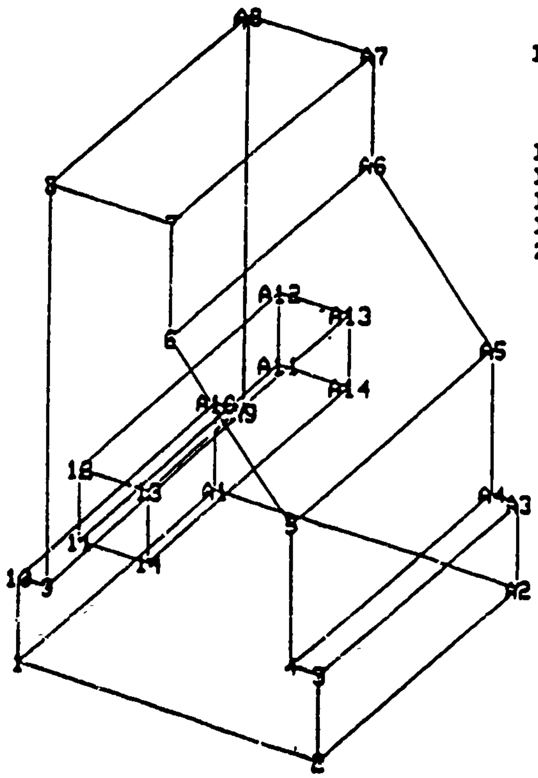


Figure 11. Fourteen points

counterclockwise order form the connectivity data of the outer boundary. Connectivity data for each hole are the same except that the point labels are given in clockwise order. Figure 12 is then generated by the data shown:



```
10 POINTS 14
   .
   .
   .
160 BLOCK -Z BL1 .1 50. 1
170 1. 1.
180 10 10 9 8 7 6 5 4 3 2 1
190 1. 1.
200 4 14 13 12 11
```

Figure 12. Generated block

29. In the preceding example, to compute the weight of the structure, a direction of -Z was given. If -Z had been omitted, the block would have been considered geometry data that could be used with simplified load commands discussed later in this report.

30. Each original point of the cross section (numbered 1, 2, 3, etc.) will have a corresponding point generated a distance DEPTH in the y direction (A1, A2, A3, etc.). The new (x, y, z) coordinates of these points are computed by:

```
XNEW = (XOLD - XAPEX) * SFX + XAPEX
YNEW = YOLD + DEPTH
ZNEW = (ZOLD - ZAPEX) * SFZ + ZAPEX
```

If SFX and SFZ are equal to one, then:

```
XNEW = XOLD
ZNEW = ZOLD
```

and XNEW and ZNEW are independent of the apex (XAPEX, ZAPEX). This allows XAPEX and ZAPEX in the data for Figure 12 to default to zero.

31. Figures 13 through 16 show data files with their corresponding plots that illustrate the impact of SFX, SFZ, XAPEX, and ZAPEX. SFX and SFZ are scale factors that scale the front x and z coordinates to determine the x and z coordinates for the back face. In like manner, HFX and HFZ determine the x and z coordinates for points halfway between the front and back faces.

32. In all the previous examples, HFX and HFZ were zero, which results in straight lines connecting the front cross section with the back cross section. To obtain a quadratic variation (shown by the data file and plot in Figure 17), interpolation points are computed to a distance of the DEPTH/2 from the front face for all the connecting line segments. The (x, y, z) coordinates of each interpolation point are computed by:

```
XINT = (XOLD - XAPEX) * HFX + XAPEX
YINT = YOLD + DEPTH * .5
ZINT = (ZOLD - ZAPEX) * HFZ + ZAPEX
```

33. This example was done with the "XZ" option turned on (default is "XZ"). If "XY" had been typed previously, SFZ is replaced by SFY, HFZ by HFY, and ZAPEX by YAPEX in paragraphs 28 through 33. In like manner, "YZ" typed previously results in replacing SFX by SFY, HFX by HFY, and XAPEX by YAPEX. Although the following discussion uses the x-z plane, the principles are the same for "XY", "YZ", and "RTz". If "RTz" has been specified before the

```
10 POIN 4
20 1 0 0 0
30 2 10 0 0
40 3 10 0 10
50 4 0 0 10
60 BLOCK +X BL1 .1 15
70 1. 1.
80 4 4 3 2 1
```

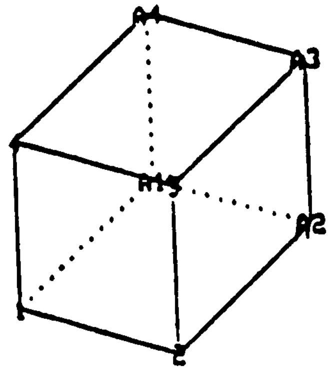
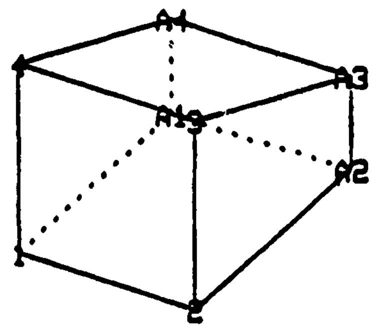


Figure 13. No scaling

Figure 14. Scaling in z only

```
10 POIN 4
20 1 0 0 0
30 2 10 0 0
40 3 10 0 10
50 4 0 0 10
60 BLOCK +X BL1 .1 15
70 1. .5
80 4 4 3 2 1
```




```
10 POIN 4
20 1 0 0 0
30 2 10 0 0
40 3 10 0 10
50 4 0 0 10
60 BLOCK +X BL1 .1 15
70 .5 .5 5. 5.
80 4 4 3 2 1
```

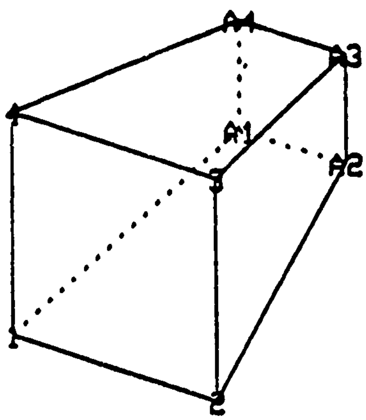
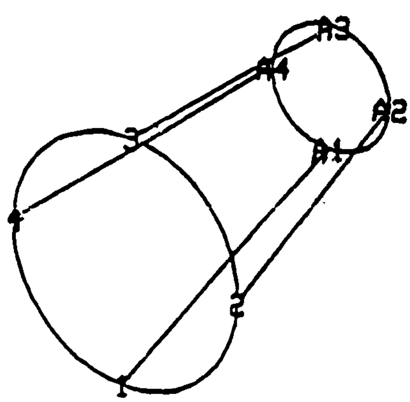


Figure 15. Scaling in x and z with nonzero apex, straight line segments

Figure 16. Scaling in x and z with circular line segments

```
10 POIN 4
20 1 0 0 -5
30 2 5 0 0
40 3 0 0 5
50 4 -5 0 0
60 CIPC 2 1 5.
70 CIRC 3 2 5.
80 CIRC 4 3 5.
90 CIRC 1 4 5.
100 BLOCK +X BL1 .1 15
110 .5 .5 0. 0.
120 4 4 3 2 1
```



```
10 POIN 4
20 1 0 0 0
30 2 10 0 0
40 3 10 0 10
50 4 0 0 10
60 BLOCK +X BL1 .1 15
70 .3 .3 5. 5. .8 .8
80 4 4 3 2 1
```

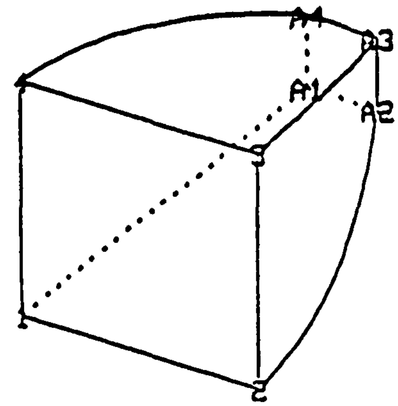


Figure 17. Quadratic variation

"BLock" command is given, DEPTH is now an angle in degrees instead of a depth, and the cross section is swept axisymmetrically instead of linearly to produce the block (Figure 6).

"FAce"

34. The "FAce" command is used to define a solid object by giving a boundary representation of its faces. Faces can consist of:

a. Planar faces with straight or cubic sides.

b. Bicubic patches defined by 16 (x, y, z) points.

The format for this command is as follows:

```
"FAce" DIR NAME DENS NFACE

  "P" NPT PT1 PT2 ... PTN
  (WHERE N = NPT)  (FOR PLANAR FACE)

                  or

  NPT PT1 PT2 ... PTN
  (WHERE N = NPT)  (FOR PLANAR FACE)

                  or

  "C" PT1 PT2 ... PT16 (FOR BICUBIC PATCH)

NOTE -- THE ABOVE INDENTED LINES ARE REPEATED
FOR EACH REMAINING FACE.
```

where

DIR = direction of the pressure volume

NAME = a four-character name

DENS = density of the object being defined

NFACE = number of faces to be defined

The connectivity of each face is designated with a "P" for a planar face (the default), or a "C" for a bicubic patch. The connectivity of a planar face consists of the number of points of the polygon followed by the point numbers. If the outward normal of the face points out of the screen (-y direction), the order of the points must be counterclockwise. The connectivity of a bicubic patch consists of 16 points given a row at a time from left to right and from bottom to top (assuming the outward normal of the patch is pointing toward the observer). Figure 18 shows one-eighth of a sphere defined using the "FAce" definition capability. The sample problem consists of one bicubic patch and three planar faces. As before, the faces must be numbered so that a right-hand screw advances toward the outward normal (holes can be produced by reversing this process) when turned in the direction of the numbering.

```
10 RTZ 50. 50. 50. 50. 50. 51.
20 POIN 14
30 1 10. 0. 0.
40 2 10. 30. 0.
50 3 10. 60. 0.
60 4 10. 90. 0.
70 5 8.66 0. 5.
80 6 8.66 30. 5.
90 7 8.66 60. 5.
100 8 8.66 90. 5.
110 9 5. 0. 8.66
120 10 5. 30. 8.66
130 11 5. 60. 8.66
140 12 5. 90. 8.66
150 13 0. 0. 10.
160 14 0. 0. 0.
170 FACE -Y SPH1 .1 4
180 C 1 2 3 4 5 6 7 8 9 10 11 12 13 13 13 13
190 P 3 14 4 1
200 P 3 14 1 13
210 P 3 14 13 4
```

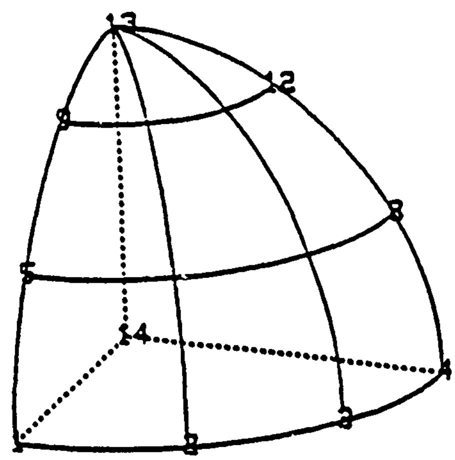


Figure 18. One-eighth of a sphere

35. Bicubic patch. This patch was chosen not only for its ability to model general shapes, but also for its accuracy when modeling conic sections. It has 16 points given by rows as shown. Four points can also coincide (as was needed in the sample) to form a triangular shaped patch. If the patch is being used to model cones, cylinders, or spheres, it is important to place the points at equal angles apart. This rule was observed in the sample problem, and the volume is in error by 0.36 percent, well within the tolerance of structural stability computations. Care must be taken in this patch to observe the right-hand rule.

36. Planar face. In an earlier version of the program, only

straight-sided polygons were allowed. However, the cubic edges created from using bicubic patches can now be a part of a planar face. Note carefully, however, that in giving the connectivity data the two intermediate points of a cubic line segments are not given.

"BR8"

37. Another way to describe geometry is by the use of the eight-node brick element. Its format is

"BR8" DIR NAME DENS

PT1 PT2 PT3 PT4 PT5 PT6 PT7 PT8

where

DIR - direction of the pressure volume

NAME - four-character name

DENS - density

Following the command, the user gives the eight nodes to define the element and connectivity (PT1 PT2 PT3 PT4 PT5 PT6 PT7 PT8). Care must be taken to number the nodes of the element correctly. Figure 19 and the data file with it illustrate a typical example. One of the several ways to accomplish the numbering is to follow the example in Figure 19 which gives the bottom four nodes counterclockwise and then the top four nodes counterclockwise while ensuring that the first and fifth, second and sixth, third and seventh, and fourth and eighth nodes, respectively, are connected.

```
10 POIN 8
20 29 0 0 10
30 30 10 0 10
40 31 10 10 10
50 32 0 10 10
60 33 0 0 20
70 34 10 0 20
80 35 10 10 20
90 36 0 10 20
100 BR8 -X B1 100
110 29 30 31 32 33 34 35 36
```

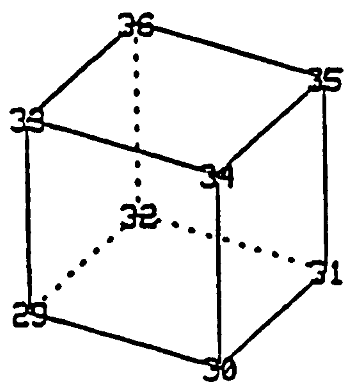


Figure 19. "BR8" command

"Translate"

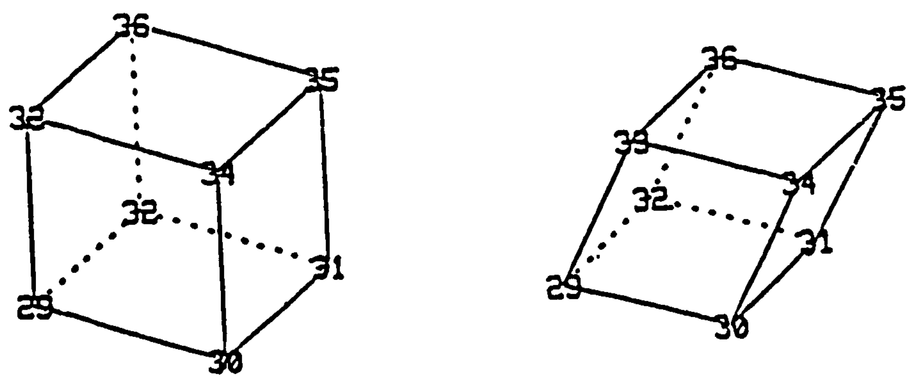
38. Objects that have been defined can be moved or translated in space from one position to another using the "Translate" command. The possible options of this command are:

```
"Translate"
"Translate" "POINts" N1 N2
"Translate" "LINEs"
"Translate" "LINEs" N1 N2
"Translate" "DENSity" DENS
"Translate" NAME
```

Points, lines, items with the same density, and items with the same name can be translated. If "Translate" is given by itself, all data are translated. Figure 20 shows an example of moving points by typing the following question and answer sequence:

```
COMMAND ?
TRAN POIN 29 32
COMMAND ?
INPUT DX, DY, DZ.
-5., 0., 0.
```

DX, DY, and DZ are the increments by which the data are to be translated.



a. Before b. After

Figure 20. "Translate" command

"ROTD"

39. This command allows the user to permanently rotate a piece of geometry about a specified axis. This is different from the "ROtp" command that temporarily rotates the picture only for easier viewing. The possible options of this command are:

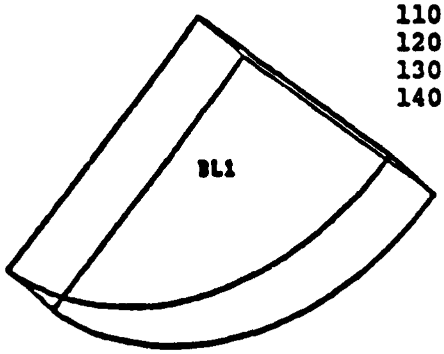
```
"ROTD" "H" ANGLE NAME XO YO ZO
"ROTD" "V" ANGLE NAME XO YO ZO
"ROTD" "O" ANGLE NAME XO YO ZO
```

"H", "V", and "O" are horizontal, vertical, and outward axes, respectively, around which rotations are made. ANGLE is a counterclockwise positive angle in degrees that determines how much the piece is to be rotated about the given

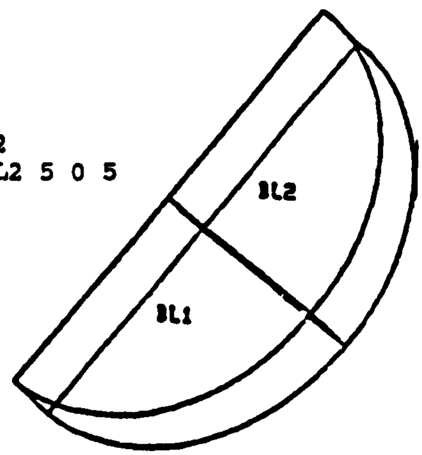
axis, NAME is the name of the piece that is to be rotated, and (XO, YO, ZO) is a point through which the given axis must pass.

40. The following data file and resulting plots shown in Figure 21 illustrate the "ROTD" command:

```
10 POIN 3
20 1 0 0 0
30 2 10 0 0
40 3 5 0 5
50 CIRC 2 1 7.072
60 BLOCK X BL1 .1 2
70 1 1
80 3 3 2 1
90 LABEL LOADS
100 ISO
110 PLOT
120 COPY BL1 BL2
130 ROTD 0 90 BL2 5 0 5
140 PLOT
```



a. Before



b. After

Figure 21. Example of "ROTD" command

"COpy"

41. This command copies or duplicates the geometry of a given name and puts it into a new name. The format of this command is

"COpy" NAME1 NAME2

where

NAME1 = volume to be copied

NAME2 = name of the resulting volume

NAME2 can now be translated or rotated in space. Figure 21 also illustrates the "COpy" command.

"REFlect"

42. The "REFlect" command allows the user to reflect or mirror a piece of geometry or pressure volume about a plane parallel to the x-y, x-z, or y-z planes. The possible options for this command are:

"REFlect" "X" XVAL NAME
"REFlect" "Y" YVAL NAME
"REFlect" "Z" ZVAL NAME

For example, to reflect an object identified by "BL1" about the horizontal plane (parallel to the x-y plane), z = 100, use the command

REF Z 100 BL1

Similar commands would be used for reflection about planes x = XVAL and y = YVAL. If "ALL" is given for NAME, the entire data base of geometry, pressure volumes, and point loads is reflected.

43. The data file and resulting plots shown in Figure 22 further illustrate the use of the "REFlect" command:

```
10 POINTS 7
20 1 80.436 0. 740.000
30 2 88.250 0. 896.270
40 3 100.000 0. 901.500
50 4 169.370 0. 847.930
60 5 212.966 0. 785.650
70 6 244.976 0. 756.344
80 7 244.976 0. 740.000
90 ELLI 3 2 11.750 5.230 RIGH
100 QUAD 3 4 134.685 0. 886.640
110 CIRC 6 5 100.000 LEFT
120 BLOCK -Z OVE1 0.15500 49.000
130 1.1
140 7 1 2 3 4 5 6 7
150 COPY OVE1 OVE2
160 REFLECT X 0. OVE2
```

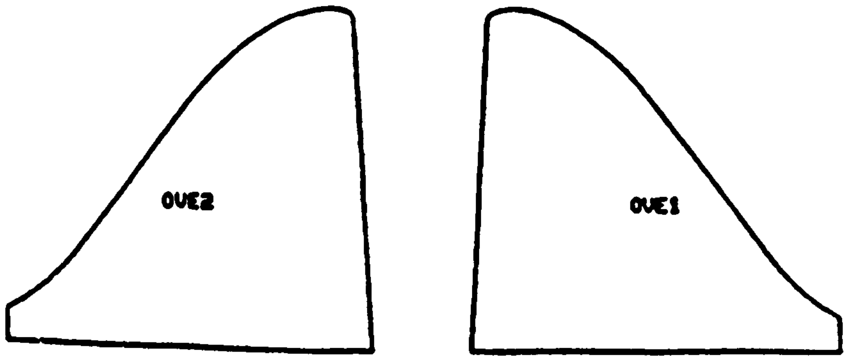


Figure 22. "REFlect" command example

"INPut"

44. This command allows the user to input or read into memory a permanent data file saved on disc. Its possible options are:

"INPut" FILENAME
"INPut" FILENAME "P"

where FILENAME is the data file. If the "P" is also typed, a detailed printout of the input file is printed on the screen just as if it had been done interactively.

"FOrce"

45. This command allows the user to obtain force and moment information, and it applies to everything except the simplified loads commands described later in this report. Its possible options are:

"FOrce"
"FOrce" "ALL"
"FOrce" NAME

If "FOrce" is typed, only the totals for the entire structure are given. If "FOrce" NAME is provided, only the load information for data having the label NAME are given. "FOrce" "ALL" will yield a detailed listing of the data by name, for example:

NAME	FX MX	FY MY	FZ MZ
V211	0. -5033.16	0. 790.28	-136.03 0.
WH11	320.00 0.	0. 89173.34	0. -11840.00
TOTAL	320.00 -5033.16	0. 89963.61	-136.03 -11840.00

"ENd"

46. This command is given to terminate running of the program, and its format is

"ENd"

"Go"

47. When the General Loads Module is entered as a result of performing an analysis of a specific structure such as a dam or lock, giving the "Go" command automatically causes the program to go from the General Loads Module to the General Analysis Module. If, however, the General Loads Module is entered by giving "LOADS" to the question

STRUCTURE TYPE OF GENERAL MODULE?

then the program is returned to this same question. The format for this command is

"Go"

"REturn"

48. This command is used to return to the question

STRUCTURE TYPE OF GENERAL MODULE?

so that the user can select another module. The format for this command is

"REturn"

"CLIp"

49. The "CLIp" command allows the user to cut or clip the geometry by an arbitrary plane to produce a new structure for use as a free-body diagram or making new loads computations. This clipped data is placed into the new data file specified by the user. Blocks, bricks, or faces not touched by the clipping plane will be placed untouched in the new file. The parts left over from a clip are converted to faces where the curved parts are modeled by bicubic patches. The possible options of this command are:

"CLIp" "X" XVAL NAME
"CLIp" "+X" XVAL NAME
"CLIp" "-X" XVAL NAME
"CLIp" "Y" YVAL NAME
"CLIp" "+Y" YVAL NAME
"CLIp" "-Y" YVAL NAME
"CLIp" "Z" ZVAL NAME
"CLIp" "+Z" ZVAL NAME
"CLIp" "-Z" ZVAL NAME
"CLIp" LAB1 LAB2 LAB3 NAME

50. The user can clip parallel to the major axes as shown in the following tabulation.

Clipping Plane

Clip command	Direction	Parallel to	Location
"CLIp" "X" XVAL	Vertical	y-z Plane	x = XVAL
"CLIp" "Y" YVAL	Vertical	x-z Plane	y = YVAL
"CLIp" "Z" ZVAL	Horizontal	x-y Plane	z = XVAL

Positive "X", "Y", or "Z" indicates that everything in the positive direction past the specified plane should be kept and the remaining pieces are thrown away; whereas "-X", "-Y", or "-Z" indicates keeping in the negative direction.

51. Clipping can also be acomplished by using three previously defined points in space to define a clipping plane. LAB1, LAB2, and LAB3 are the labels of these three previously defined points in space. If a right-hand screw is advanced in the direction of the specified points, then the screw points in the direction of the data which is retained.

52. NAME results in a specific piece of geometry or loads being clipped, and the unclipped pieces are also placed into the clipped data file. If NAME is not specified, the entire geometry and loads are clipped.

53. When the "CLIp" command is given, the program asks for two output data files where the new clipped data are to be placed. The first data file contains the solid geometry description (blocks, bricks, faces, etc.), and the second contains a definition of the resulting base or cross section of the intersection of the clipping plane and the original geometry. After the clip is complete, the program returns to the command level.

54. Consider the sample data file (called SAMDAT):

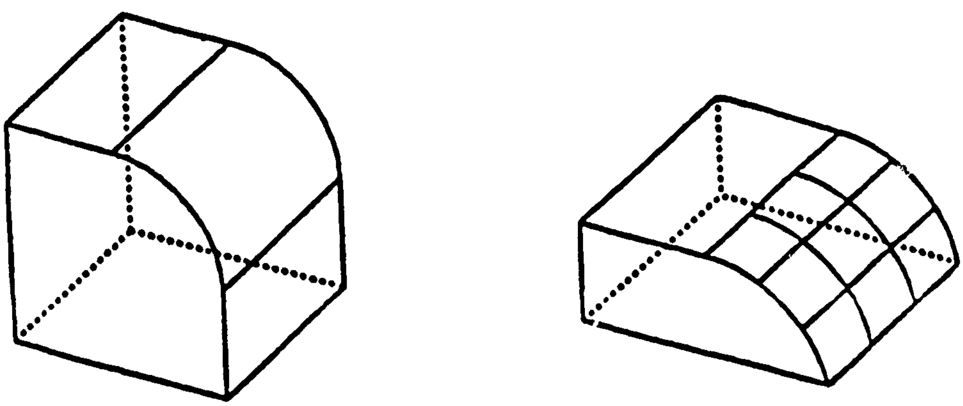
```
10 POIN 5
20 1 0. 0. 0.
30 2 10. 0. 0.
40 3 10. 0. 5.
50 4 5. 0. 10.
60 5 0. 0. 10.
70 CIRC 4 3 5.
80 BLOCK BL1 .1 10.
90 1. 1.
100 5 5 4 3 2 1
```

The question and answer sequence for a clip on SAMDAT is as follows:

```
COMMAND ?
INP SAMDAT
COMMAND ?
CLIP Z 6.

     ENTERING CLIPPING MODULE.

OUTPUT GEOMETRY DATA FILE ?
CLGEOM

OUTPUT BASE DATA FILE ?
CLBASE

CLIPPING BL1

     EXITING CLIPPING MODULE.

COMMAND ?
```

The resulting output geometry data file is shown and plotted in Figure 23.

```
20000 POINTS    20
20000     1          .00           .00        6.00
20000     2          .00           .00       10.00
20000     3          .00         10.00       10.00
20000     4          .00         10.00        6.00
20000     5         5.00           .00       10.00
20000     6         5.00         10.00       10.00
20000     7         9.91           .00        6.00
20000     8         9.91          3.33        6.00
20000     9         9.91          6.67        6.00
20000    10         9.91         10.00        6.00
20000    11         8.96           .00        8.05
20000    12         8.96          3.33        8.05
20000    13         8.96          6.67        8.05
20000    14         8.96         10.00        8.05
20000    15         7.21           .00        9.49
20000    16         7.21          3.33        9.49
20000    17         7.21          6.67        9.49
20000    18         7.21         10.00        9.49
20000    19         5.00          3.33       10.00
20000    20         5.00          6.67       10.00
20000 FACE        BL1         .1000     6
20000 C      7    8    9   10   11   12   13   14   15   16
20000    17   18    5   19   20    6
20000     4    1    2    3    4
20000     4    2    5    6    3
20000     4    7    5    2    1
20000     4    4    3    6   10
20000     4    4   10    7    1
```



a. Before

b. After

Figure 23. "CLIp" command example

The base file produced is as follows:

```
20000 POINTS     4
20000     1          .00           .00        6.00
20000     7         9.91           .00        6.00
20000    10         9.91         10.00        6.00
20000     4          .00         10.00        6.00
20000 BASE
20000     4     1     7    10     4
```

This file can be used in the General Analysis Module and is produced only if a block does not have a direction associated with it and thus is a piece of geometry instead of a load.

"CLEar"

55. This command is used to clear all definition of geometry and loads from memory to begin a new problem, and its format is

"CLEar"

"PTld"

56. Four load building commands that exist in conjunction with the pressure volume capability are "PTld", "QUAKe", "Uplift", and "CAse". To illustrate these four commands, consider the geometry file in Table 1 and the loads file in Table 2.

Table 1

Geometry File

```
20000 POINTS    18
20010      1      0.            0.          95.500
20020      2      0.            0.         109.000
20030      3       3.000        0.         109.000
20040      4       3.000        0.         109.000
20050      5       3.000        0.         109.000
20060      6       3.000        0.         109.000
20070      7       3.000        0.         193.500
20080      8     13.000         0.         193.500
20090      9     13.000         0.         193.500
20100     10     13.000         0.         193.500
20110     11     13.000         0.         178.500
20120     12     72.280         0.         100.500
20130     13     72.280         0.         100.500
20140     14     72.280         0.          95.500
20150     15      5.000         0.         180.000
20160     16      5.000         0.         187.000
20170     17      9.000         0.         187.000
20180     18      9.000         0.         180.000
20190 BLOCK NON1     0.15000      10.000     1
20200        1.000       1.000
20210  14  1  2  3  4  5  6  7  8  9 10 11 12 13 14
20220        1.000       1.000
20230   4 18 17 16 15
```

Table 2

Loads File

```
19990 PTLD   WT   26.68   5   128.34   0   0   -5401.23
20000 POINTS    3
20010     1    -10.000       0.        186.500
20020     2    -10.000       0.         95.500
20030     3    -19.282       0.         95.500
20040 QUAD    3    1     -14.641      0.          163.750
20050 BLOCK  +X  EQ10    0.05000      10.000
20060        1.000        1.000
20070     3    1    2    3
20080 POINTS    3
20090     4     10.000       0.        122.900
20100     5     10.000       0.         95.500
20110     6     12.795       0.         95.500
20120 QUAD    4    6      11.397      0.          116.050
20130 BLOCK  +X  EQ50    0.05000      10.000
20140        1.000        1.000
20150     3    6    5    4
20160 POINTS    8
20170     7     0.           0.         95.500
20180     8     0.           0.        109.000
20190     9     3.000        0.        109.000
20200    10     3.000        0.        109.000
20210    11     3.000        0.        109.000
20220    12     3.000        0.        109.000
20230    13     3.000        0.        186.500
20240    14     0.           0.        186.500
20250 BLOCK  -Z  V210    0.06250      10.000
20260        1.000        1.000
20270     8   14    13    12    11    10     9    8    7
20280 POINTS    4
20290    15     72.280       0.        122.900
20300    16     55.256       0.        122.900
20310    17     72.280       0.        100.500
20320    18     72.280       0.        100.500
20330 BLOCK  -Z  V250    0.06250      10.000
20340        1.000        1.000
20350     4   18    17    16    15
20360 POINTS    3
20370    19    -29.282       0.        186.500
20380    20    -29.282       0.         95.500
20390    21    -47.482       0.         95.500
20400 BLOCK  +X  WH10    0.31250      10.000
20410        1.000        1.000
20420     3   19    20    21
20430 POINTS    3
20440    22     22.795       0.        122.900
20450    23     22.795       0.         95.500
20460    24     28.275       0.         95.500
20470 BLOCK  -X  WH50    0.31250      10.000
20480        1.000        1.000
20490     3   24    23    22
20540 TRAN EQ50
20550           72.280 0. 0.
20560 TRAN WH50
20570           72.280 0. 0.
20580 UPLIFT  4
20590 A   5.68750
20600 B   1.71250
20610 C   1.71250
20620 D   5.68750
20630 QUAKE EQN +X    0.100  1
20640  WT
20650 CASE  VI  3   8
20660  WT    V210 V250 WH10 WH50
20670  EQ10 EQ50 EQN
```

When the loads file is added to the geometry file, the combined plot is given in Figure 24. (Note: these two data files were generated by the CDAMS Module.) "PTld" is a command to describe a point load, and its format is

"PTld" NAME XX YY ZZ FX FY FZ

where

NAME = name given to the point load

XX, YY, and ZZ = (x, y, z) coordinates where the point load is to be applied

FX, FY, and FZ = components of the point load

The load WT in Figure 24 is a point load representing the weight of the structure, as represented by line 19990 in Table 2.

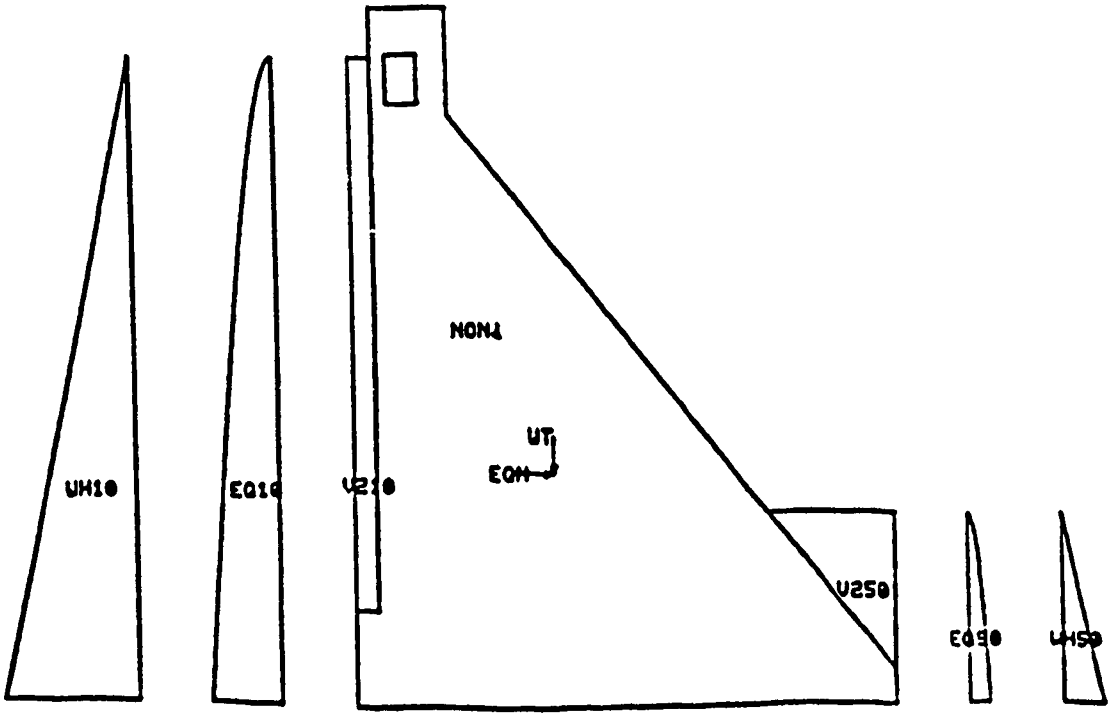


Figure 24. Combined plot

<u>"QUAKe"</u>

57. This command allows the user to apply a seismic coefficient to a given load when computing earthquake loads, and a new point load is generated in the specified direction representing the earthquake load. The format for the command is:

```
"QUAKe" NAME DIR COEF NUMLDS
LNAME1 LNAME2 . . . .
. . . . LNAMEn        (WHERE n = NUMLDS)
```

where

NAME = name of the new generated point load

DIR = direction of the new point load

COEF = seismic coefficient

NUMLDS = number of loads where the seismic coefficient is to be applied

LNAME1, LNAME2 . . . LNAMEn = names of the loads where the seismic coefficient is applied

Lines 20630 through 20640 in the loads data file of Table 2 and EQN in Figure 24 demonstrate the use of the "QUAKe" command.

"Uplift"

58. This command is used if uplift loads are to be computed later by the General Analysis Module. It gives the uplift values for points on the base of the foundation where overturning and sliding stability are computed. Uplift data are linked to case data described below. The format of the command is

"Uplift" NPT

where NPT is the number of base points that require uplift to be specified. After this line of data, the information requested for each base point is

LABEL UPLIFT

where LABEL is the base point label and UPLIFT is the uplift value for the base point. An example of this command is shown in lines 20580 through 20620 of the loads file in Table 2.

"CAse"

59. This command allows the user to combine several load names into a load case. Its format is:

```
"CAse" CNAME LDTYPE NUMLDS
LNAME1 LNAME2 . . . .
. . . . LNAMEn        (WHERE n = NUMLDS)
```

where

CNAME = name of the case

LDTYPE = flag used in the General Analysis Module (1 - short term, 2 - long term, and 3 - instantaneous)

NUMLDS = number of load names to combine

LNAME1 LNAME2 . . . LNAMEn = load names

In Table 2, lines 20650 through 20670 of the loads file illustrate the use of this command.

<u>"PLot"</u>

60. This command allows part or all of the data base to be plotted, and its possible options are:

```
"PLot"
"PLot" "LINEs"
"PLot" "LINEs" N1 N2
"PLot" "POINts"
"PLot" "POINts" N1 N2
"PLot" "DENSity" DENS
"PLot" NAME
```

The default code is "LINEs", and when "PLot" is issued all the lines will be plotted. Points can be plotted by typing "PLot" "POINts". If N1 and N2 are given, only those lines or points between N1 and N2 are plotted. All data with a given density (DENS) or name (NAME) can be plotted by using "PLot" "DENSity" DENS or "PLot" NAME, respectively. Figure 25 shows an example of a plot.

<u>"Window"</u>

61. This command allows the user to plot a portion of the screen by picking a window, and its format is

"Window"

Figure 26 shows a window of the pressure volume in Figure 25. The cross hairs or cursor will then appear, and the user should place them on the lower left-hand corner of the desired window and type any character (some graphics terminals are scrapped, so that a carriage return is needed). These cross hairs will reappear and this process should be repeated for the upper right-hand corner. Figure 25 shows a full picture of a pressure volume, while Figure 26 shows a window of that plot.

<u>"Zoom"</u>

62. This command allows the user to decrease or increase the size of the current picture on the screen. The format for this command is

"Zoom" FMAG

where FMAG is a scale factor indicating whether the current picture is made larger or smaller. Depending upon whether FMAG is less than or greater than 1, the picture is decreased or increased in size, respectively.

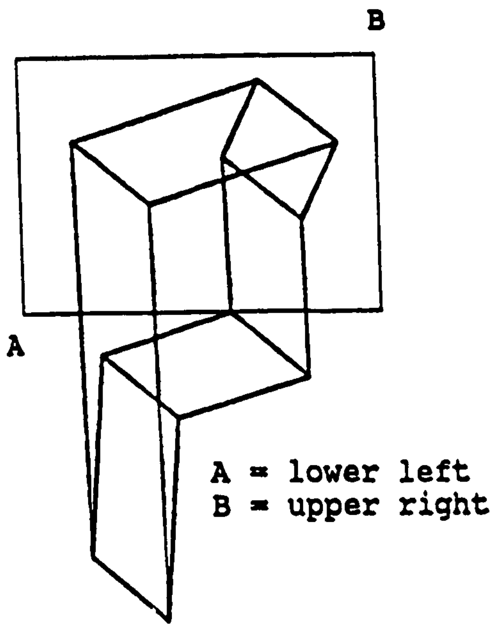


Figure 25. Full picture of
pressure volume

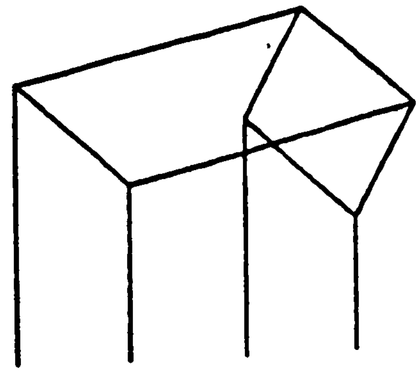


Figure 26. Window of
Figure 25 pressure
volume

<u>"ROtp"</u>

63. This command allows the user to rotate a picture of the structure for viewing at different angles. It changes only the screen picture, not the geometry, whereas the "ROTD" command permanently rotates the geometry or loads to a new position. Its possible options are:

```
"ROtp" "H" ANGLE
"ROtp" "V" ANGLE
"ROtp" "O" ANGLE
```

where

"H" = horizontal axis

"V" = vertical axis

"O" = outward axis

ANGLE = a counterclockwise, positive angle in degrees that determines how much the structure is to be rotated about the given axis.

The distinction between a (x, y, z) coordinate system and the rotation axes is shown in the following example:

ROTP V 30.
ROTP H 30.

Rotation Axes

Coordinate System

"ISometric"

64. This command allows the user to specify a standard set of rotation data rather than search for the desired plot, and its format is

"ISometric"

It is equivalent to the two rotations given above.

"Label" and "Nolabel"

65. "Label" allows labels to be plotted with line segments. Two types of labels are available: (a) point labels and (b) name labels. "Nolabel" (the default) turns off the label options. The possible options for these commands are:

"Label" "Points"	or	"Nolabel" "Points"
"Label" "Loads"		"Nolabel" "Loads"

Figure 27 illustrates the labeling of points by showing the results of typing

```
LABEL POINTS
PLOT
```

Figure 21 shows an example of labeling the names of loads pieces.

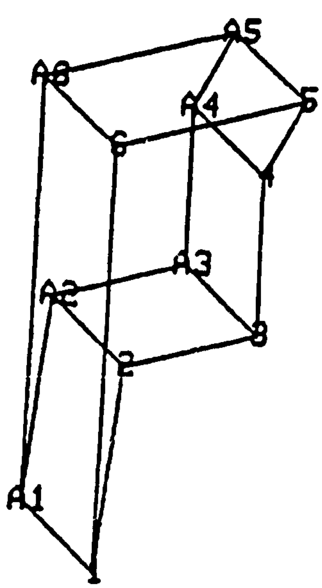


Figure 27. "Label" "Points" command

"Dash", "Hide", and "Solid"

66. "Dash" allows the user to dash the lines that are hidden from view, whereas "Hide" allows the user to delete these hidden lines. "Solid" (the default) causes all the lines to be solid. The format for these commands are

"Dash" or "Hide" or "Solid"

Figure 28 shows the results of dashing the plot in Figure 25, whereas Figure 29 shows the use of "Hide".

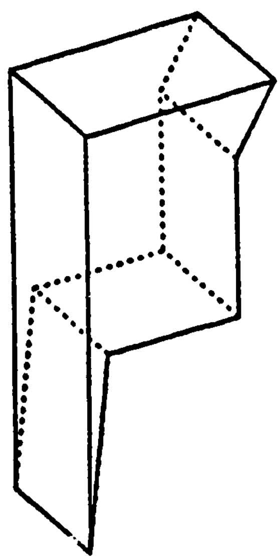


Figure 28. "Dash" command

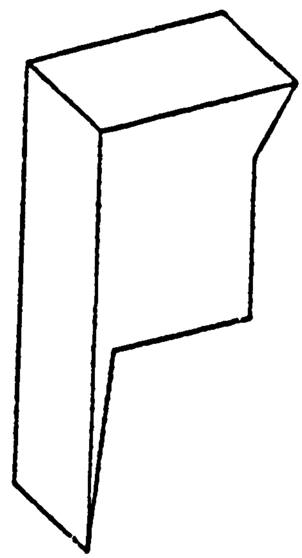


Figure 29. "Hide" command

"COLor"*

67. This command allows the user to set the color of pieces of geometry or loads. The possible options for this command are:

"COLor" "WHITe" NAME
"COLor" "BLUE" NAME
"COLor" "GREEn" NAME
"COLor" "CYAN" NAME
"COLor" "RED" NAME
"COLor" "MAGEnta" NAME
"COLor" "YELLow" NAME
"COLor" "BLACk" NAME

where NAME is the name of the piece of geometry or loads. The default color is "WHITe".

---

* PC and Intergraph engineering workstations only.

"ERase"

68. This command erases the screen, and its format is

"ERase"

"INItialize"

69. This command initializes plot data back to the original values, and its format is

"INItialize"

When this command is given, the angle of rotation is reset to zero.

"SHAded"*

70. This command is similar to the "PLot" command, except that instead of a wire-frame plot, a continuous tone shaded plot is generated. The different options for this command are:

"SHAded"
"SHAded" "DENSity" DENS
"SHAded" NAME

The entire data base will be plotted when "SHAded" is given. Data with the same density (DENS) or the same name (NAME) can also be plotted. Figure 30 illustrates an overflow cross section of a dam with a pier and two gates, provided by Bill Kling, US Army Engineer District, Mobile, as a shaded plot.

"SHOwload"*

71. This command is used to display the simplified loads described in pragraphs 73 through 81, and its format is

"SHOwload" NAME

where NAME is the name of a simplified load to be displayed. If "Solid" is turned on, a shaded solid plot is produced, whereas if "Hide" or "Dash" had previously been issued, a hidden or dashed line plot, respectively, is generated. A water load will be plotted in light blue, and a soil load in brown. An example showing a water load with the hidden line option is given in Figure 31. Figure 32 shows an upstream water load on the structure in Figure 30, and Figure 33 shows the pressure volumes required to give the equivalent result with both plots being shaded drawings.

---

* PC and Intergraph engineering workstations only.

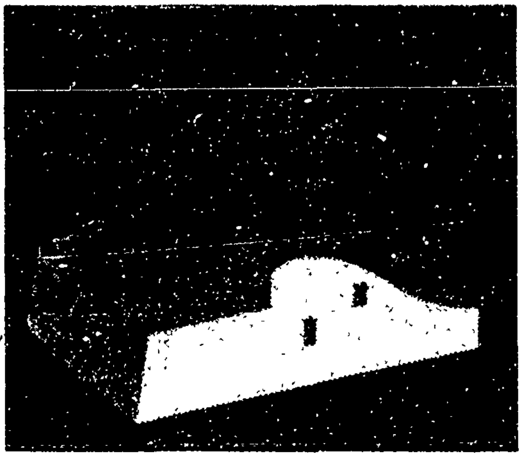


Figure 30. "SHAded" example

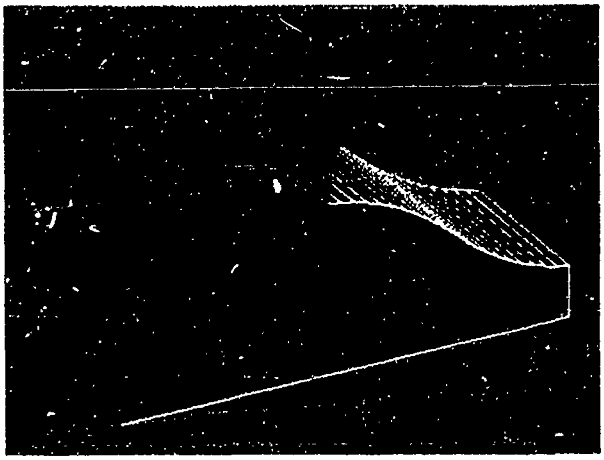


Figure 31. "SHOwload" example

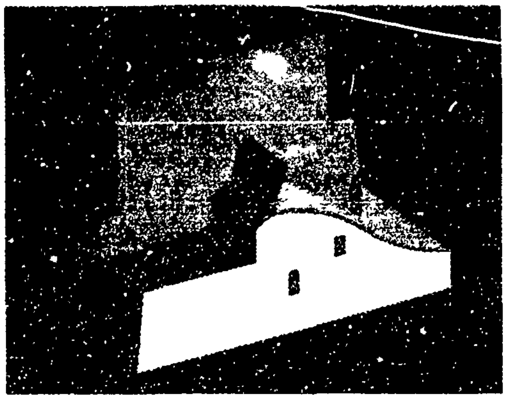


Figure 32. Simplified loads

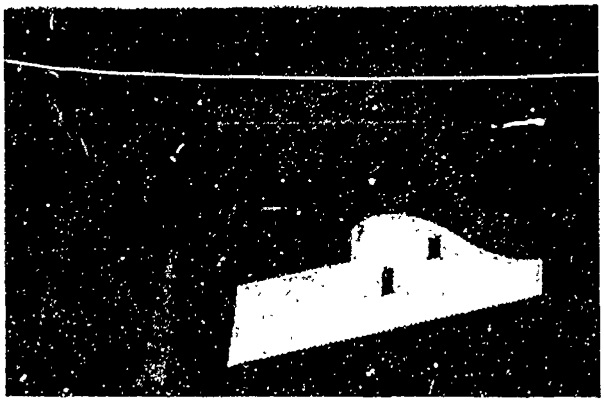


Figure 33. Pressure volumes

"BAckground"*

72. This command allows the user to set the background color of the screen for continuous tone shaded plots generated by the "SHAded" or "SHOw-load" command. The possible options for this command are:

```
"BAckground" "BLUE"
"BAckground" "WHITe"
"BAckground" "GREEn"
"BAckground" "CYAN"
"BAckground" "RED"
"BAckground" "MAGEnta"
"BAckground" "YELLow"
"BAckground" "BLACk"
```

The default color is "BLUE".

Simplified Load Commands

73. A set of commands separate from the pressure volume capability are the simplified load commands that provide an alternative to point loads and pressure volumes used to compute general loads. Five commands are described that have been implemented to date with examples referring to Figure 34. This figure shows part of an overflow cross section and a gate to which water and soil loads will be applied. The geometry data (stored in file GO) for the structure in Figure 34 are:

```
20000 POINTS    9
20010      1      0.           0.         268.000
20020      2       1.500       0.         283.000
20030      3      20.700       0.         283.000
20050      4      20.700       0.         288.940
20060      5      24.230       0.         291.000
20080      6      40.020       0.         282.560
20100      7      54.230       0.         275.000
20130      8      54.230       0.         268.000
20290      9      26.369       0.         300.000
20220 QUAD    4     5      22.465       0.          290.485
20230 QUAD    5     6      32.125       0.          288.658
20240 CIRC    7     6      28.000 LEFT
20250 BLOCK OVE1    0.15000      20.000
20260       1.000       1.000
20270     8     1     2     3     4     5     6     7     8
20300 CIRC    9     5      20.000 RIGH
20310 BLOCK GATE    0.06250      20.000
20320       1.000       1.000
20330     4     5     9     9     5
20340 COLOR RED GATE
```

---

* PC and Intergraph engineering workstations only.

while simplified load data (stored in file LOS) are:

```
10 DENSW .0625
20 WATER HEAD 296
30 WATER TAIL 270
40 LOAD BLOCK OVE1 SIDE 1 5 HEAD
50 LOAD BLOCK OVE1 SIDE 5 8 TAIL
60 LOAD BLOCK GATE SIDE 5 9 HEAD
70 SOIL 1
80 S1 268. 278. .075 .35 .35 1.
90 LOAD BLOCK OVE1 SIDE 1 5 S1
```

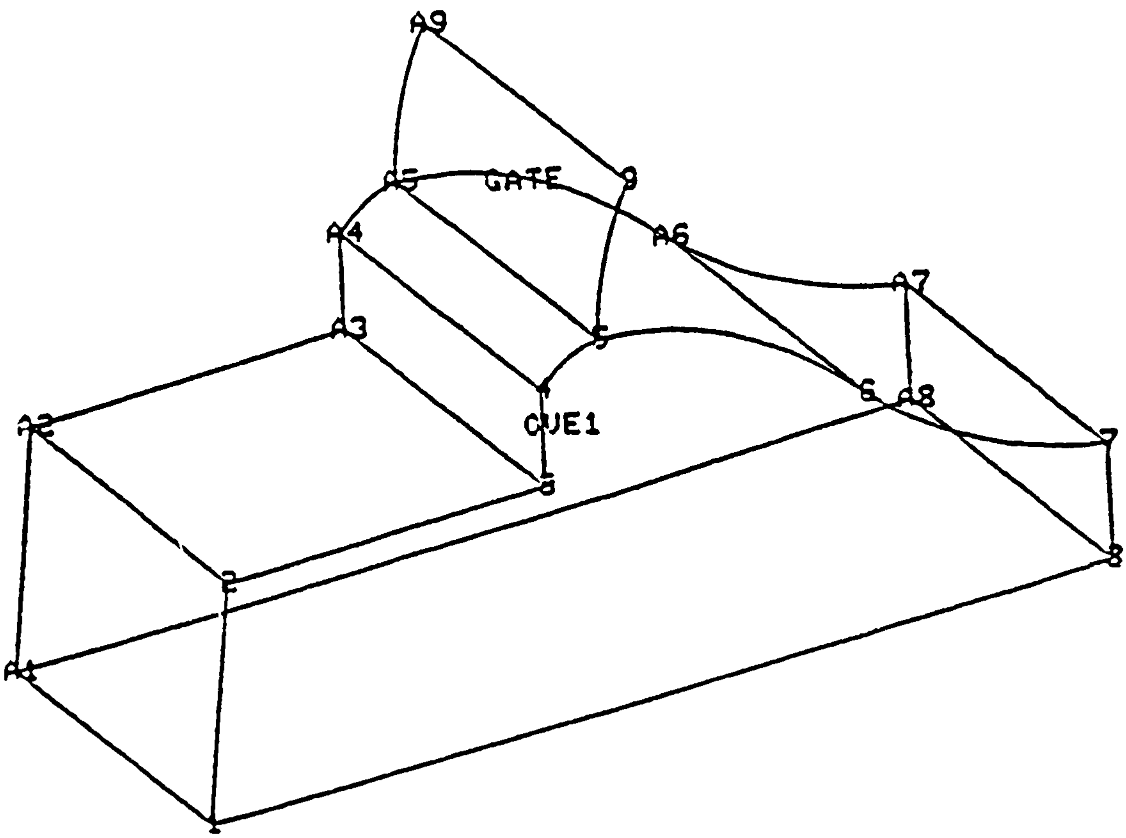


Figure 34. Overflow cross section with gate

"DEnsw"*

74. This command sets the density of water, and its format is

"DEnsw" DENSW

where DENSW is the density of water. The default value is 0.0625, and an example of this command is given in line 10 of the LOS file.

---

* PC and Intergraph engineering workstations only.

"WAter"*

75. This command allows the user to define and name a water level, and its format is

"WAter" LOAD_NAME ELEVATION

where

LOAD_NAME = load name

ELEVATION = elevation of the pool of water

An example establishing headwater and tailwater is given in lines 20 through 30 of the LOS file.

"SOIl"*

76. This command, similar to the "WAter" command, is used to establish horizontal soil layers. The format of the command is:

```
"SOIl" NUMBER_OF_LAYERS
  (For each layer from top to bottom give)
  LAYER_NAME EL_BOTTOM EL_TOP EFFECTIVE_UNIT_WEIGHT KX KY KZ
```

where

NUMBER_OF_LAYERS = number of soil layers

LAYER_NAME = name of the soil layer

EL_BOTTOM = elevation of the bottom of the soil layer

EL_TOP = elevation of the top of the soil layer

EFFECTIVE_UNIT_WEIGHT = effective unit weight of the soil (typically the buoyant unit weight for soil in water)

KX = soil coefficient in the x direction (varies depending on active, passive, or at rest type conditions)

KY = soil coefficient in the y direction

KZ = soil coefficient in the z direction

Lines 70 through 80 in the LOS file illustrate the use of this command.

"LOAD"*

77. This command allows the user to connect the water and soil levels to the geometry. Its format differs depending upon the type of geometry being loaded, and these formats are:

---

* PC and Intergraph engineering workstations only.

------ BLOCKS ------

```
"LOAD" "BLock" BLOCK_NAME "Side" FIRST_POINT
     SECOND_POINT LOAD_NAME
"LOAD" "BLock" BLOCK_NAME "Side" "ALL" LOAD_NAME
"LOAD" "BLock" BLOCK_NAME "Front" LOAD_NAME
"LOAD" "BLock" BLOCK_NAME "Back" LOAD_NAME
```

------ FACES ------

```
"LOAD" "Face" FACE_NAME FIRST_FACE LAST_FACE
     LOAD_NAME
"LOAD" "Face" FACE_NAME "ALL" LOAD_NAME
```

------ BRICKS ------

```
"LOAD" "BRick" BRICK_NAME FIRST_FACE LAST_FACE
     LOAD_NAME
"LOAD" "BRick" BRICK_NAME "ALL" LOAD_NAME
```

where

BLOCK_NAME = name of a block

BRICK_NAME = name of a brick to be loaded

FACE_NAME = name of a cluster of faces to be loaded

FIRST_FACE = number of the first face to be considered

FIRST_POINT = first point defining where on the block the load is to start to be considered

LAST_FACE = number of the last face to be considered

LOAD_NAME = name of the load to be applied

SECOND_POINT = second point defining where on the block the load is to stop being considered

78. Blocks can be loaded on the two ends (front or back), an entire side, or part of a side. Care must be taken to give the point numbers of a block in the same order that the block was originally defined. Lines 40 through 60 and 90 in the LOS data file illustrate the use of the "LOAD" command.

79. The faces of a brick element are numbered in a set way (Figure 35), and they will be described in terms of the first node, second node, etc. of the brick as follows:

Face Number	Face Description
1	4, 3, 2, 1
2	5, 6, 7, 8
3	1, 2, 6, 5
4	2, 3, 7, 6
5	3, 4, 8, 7
6	4, 1, 5, 8

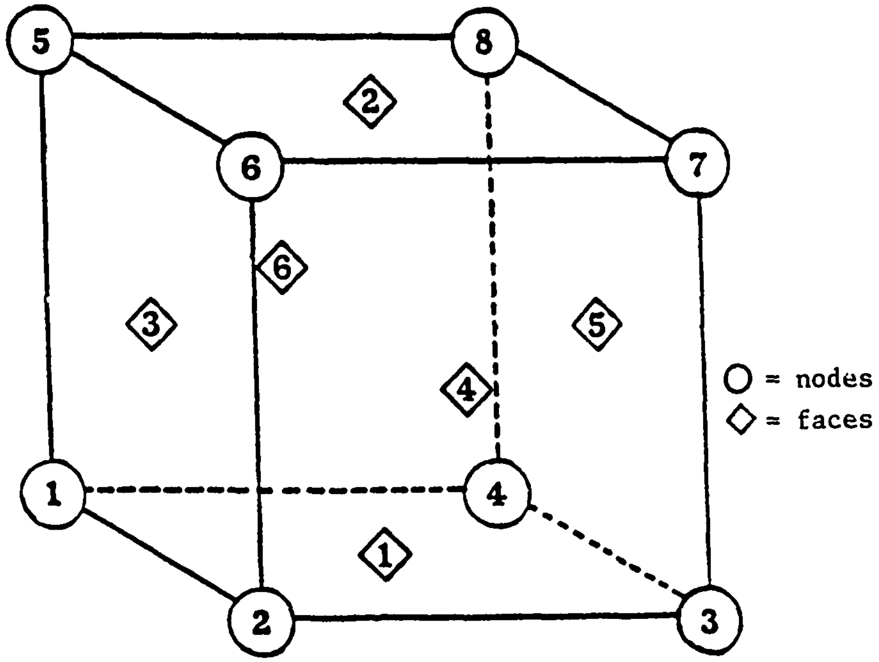


Figure 35. Faces of a brick element

Therefore, the face numbers of the brick will be "ALL" or one of the predefined numbered faces.

80. The command "SHOwload", described in paragraph 71, is an excellent way to ensure that the correct faces have been loaded. The following question and answer sequence yields the plot of Figure 31.

```
COMMAND ?
INPUT GO
COMMAND ?
INPUT LOS
COMMAND ?
ISOMETRIC
COMMAND ?
HIDE
COMMAND ?
SHOW HEAD
```

"SLoads"*

81. This command allows the user to compute the values of the simplified loads. The possible options for this command are:

```
"SLoads"
"SLoads" "ALL"
"SLoads" NAME
```

---

* PC and Intergraph engineering workstations only.

where NAME is the name of a water or soil layer to be evaluated. "SLoads" is used to give the sum total, whereas "SLoads" "ALL" will print a detailed summary, and "SLoads" NAME will print the results for a particular name. For the sample problem given in paragraph 73, the command

SLOADS ALL

will produce the following result:

NAME	FX MX	FY MY	FZ MZ
HEAD-OVE1	474.38	.00	-375.53
	-3755.30	135370.00	-4743.75
TAIL-OVE1	-2.50	.00	.00
	.00	-671.67	25.00
HEAD-GATE	15.63	.00	-1.32
	-13.20	4605.14	-156.25
S1 -OVE1	26.25	.00	-7.50
	-75.00	7125.00	-262.50
TOTAL	513.75	.00	-384.35
	-3843.50	146428.40	-5137.50

REFERENCES

Tracy, Fred T. 1980. "A Three-Dimensional Stability Analysis/Design Program (3DSAD), General Geometry Module," Instruction Report K-80-4, Report 1, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

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__________. 1987a. "A Three-Dimensional Stability Analysis/Design Program (3DSAD), General Geometry Module," Instruction Report ITL-87-3, Report 1, Revision 1, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

__________. 1987b. "A Three-Dimensional Stability Analysis/Design (3DSAD) Computer Program for Concrete Monolithic Structures," Computer Applications in Concrete Technology, San Antonio, SP-106, American Concrete Institute, Detroit, MI, pp 159-176.

Tracy, Fred T., and Kling, Charles W. 1982. "A Three-Dimensional Stability Analysis/Design Program (3DSAD), General Analysis Module," Instruction Report K-80-4, Report 3, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Tracy, Fred T., Kling, Charles W., and Holtham, William J. 1983. "A Three-Dimensional Stability Analysis/Design Program (3DSAD), Special Purpose Module for Dams (CDAMS)," Instruction Report K-80-4, Report 4, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

APPENDIX A: ALPHABETIZED LIST OF COMMANDS

Command	Page	Description
BACKGROUND	40	Set the background color
BLOCK	16	Extrude a cross section to form a block
BR8	22	Define an eight-node brick element
CASE	33	Define a load case
CIRCLE	14	Define a circular arc
CLEAR	30	Clear memory of old data
CLIP	27	Clip the geometry or loads
COLOR	37	Assign a color to a piece of data
COPY	24	Copy a piece of data
DASH	37	Turn on dashed lines
DENSW	41	Define density of water
ELLIPSE	15	Define an elliptical arc
END	26	End execution of program
ERASE	38	Erase screen
FACE	20	Define a group of faces to form a solid
FORCE	26	Compute forces and moments
GO	26	Go to next module
HIDE	37	Turn on hidden lines
INITIALIZE	38	Initialize graphics
INPUT	25	Input a data file
ISOMETRIC	36	Rotate data for isometric plot
LABEL	36	Turn on labeling of data
LOAD	42	Apply simplified loads to geometry
NOLABEL	36	Turn off labeling of data
PLOT	34	Plot data
POINTS	14	Define a set of points
PTLD	30	Define a point load
QUADRATIC	16	Define a quadratic line segment
QUAKE	32	Define an earthquake load
REFLECT	24	Reflect or mirror a piece of data
RETURN	27	Return to select another module
ROTD	23	Rotate a piece of data and save
ROTP	35	Rotate current plot
RTZ	13	Select radius-theta-z plane for blocks
SHADED	38	Draw a continuous tone shaded plot
SHOWLOAD	38	Show a simplified load
SLOADS	44	Compute simplified loads
SOIL	42	Define soil layers
SOLID	37	Turn on solid lines
TRANSLATE	22	Translate a piece of data
UPLIFT	33	Define a set of uplift values
WATER	42	Define a water level
WINDOW	34	Plot a window or portion of the plot
XY	12	Select x-y plane for blocks
XZ	12	Select x-z plane for blocks
YZ	12	Select y-z plane for blocks
ZOOM	34	Zoom relative to current plot

SPECIFIC SYSTEM INFORMATION

Introduction

This insert gives specific information for running the Three-Dimensional Stability Analysis/Design (3DSAD) program on different computer systems.

Description of Program

3DSAD, called X8100 in the Conversationally Oriented Real-Time Program-Generating System (CORPS) Library, is a program for a three-dimensional stability analysis/design of hydraulic structures. The General Loads Module documented in the enclosed report provides general capability for computing the forces and moments from water, soil, earthquake, and miscellaneous loads.

Coding and Data Format

3DSAD is written in FORTRAN and is operational on the following systems:

a. US Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss., and Division office Honeywell DPS/8.

b. Cybernet Computer Service's CDC Cyber 175.

c. District office Harris 500.

d. DEC VAX systems.

e. Apollo engineering workstation.

f. Intergragh engineering workstations.

g. PC.

Data must be prepared in a data file with line numbers or given interactively without line numbers. Interactive output comes directly back to the terminal or computer monitor, and auxiliary plots are available on a drum plotter or printer, depending on the system. The graphics terminal used with Honeywell, CDC, Harris, and VAX must be a Tektronix 4014 or equivalent.

How to Use 3DSAD

Directions for accessing the program for each of the seven computers is given. It is assumed that the user can sign on or initialize the appropriate system before executing 3DSAD. In the instructions, information given by the computer is in all capitals, and user responses are in boldface type. When

actually running the program, each user response is also followed by pressing the "Carriage Return" or "Enter" key.

Honeywell System

After signing onto the system, the user issues the command

FORT

to bring the user to the proper level to execute the program. Next, the user issues the run command

RUN WESLIB/CORPS/X8100,R

to initiate execution of the program. The program is then run as indicated in this user's guide. A data file is typically prepared prior to issuing the run command. An example initiation of execution is as follows:

```
USER ID -- ROMONEY
PASSWORD - SECRET
*FRN WESLIB/CORPS/X8100,R
```

Cybernet System

The log-on procedure is followed by a call to the CORPS procedure file to access the CORPS Library as follows:

OLD,CORPS/UN=CECELB

The command

BEGIN,,CORPS,X8100

is then given to initiate execution of 3DSAD. An example is:

```
FAMILY:  KOE
USER NAME:  CEMONEY
PASSWORD -
SECRET
RECOVER/CHARGE:  CHARGE,CEROEGC,CEMONEY
/OLD,CORPS/UN=CECELB
/BEGIN,,CORPS,X8100
```

Harris 500 System

The log-on procedure is followed by a call to the program executable file with the user typing the asterisk and file description as follows

*CORPS,X8100

to initiate execution of the program. An example is:

```
ENTER SIGN-ON
1234ABC,STRUCT
*CORPS,X8100
```

DEC VAX System

The log-on procedure is followed by executing the program. If 3DSAD is installed under the subdirectory CORPS with the executable file name X8100, type

RUN [CORPS]X8100

to initiate execution of the program. For example,

```
USERNAME:VOMONEY
PASSWORD:SECRET
$ RUN [CORPS]X8100
```

Apollo and Intergraph Engineering Workstations

Assuming that 3DSAD is installed under the subdirectory CORPS with the executable file name X8100, then type

/CORPS/X8100

to initiate execution of the program.

PC

3DSAD runs on a PC with the following characteristics:

a. DOS operating system (required).

b. 640K of memory (required).

c. CGA, EGA, or VGA graphics card and monitor (required).

d. Hard disk (required).

e. Math coprocessor (recommended).

Because of its size, 3DSAD is broken into separate versions that are installed as separate executable files. They are:

a. X8100 - Contains CDAMS, basic General Geometry Module, basic General Loads Module, and General Analysis Module.

b. X8100E - Contains enhanced General Geometry and Loads Modules, including full hidden line and continuous tone shaded plot capability and simplified loads commands.

c. X8100F - Contains Free-Body Module and basic General Geometry and Loads Modules with increased dimensions.

d. X8100L - Contains CLOCKS, basic General Geometry Module, basic General Loads Module, and General Analysis Module.

To initiate execution of 3DSAD, go to the subdirectory where the desired executable is stored and type the executable name. For example, to run the enhanced General Loads Module, type

X8100E

How to Use CORPS

The CORPS system contains many other useful programs that may be catalogued from CORPS by use of the LIST command. The command sequence for this on the Honeywell is:

```
RUN WESLIB/CORPS/X8100,R
ENTER COMMAND (HELP, LIST, BRIEF, MESSAGE, EXECUTE, OR STOP)
*?LIST
```

On the Cybernet system the commands are:

```
OLD,CORPS/UN=CECELB
BEGIN,,CORPS
ENTER COMMAND (HELP, LIST, BRIEF, MESSAGE, EXECUTE, OR STOP)
*?LIST
```

On the Harris system the commands are:

```
*CORPS
ARE YOU USING A PRINTER TERMINAL OR CRT?
ENTER P OR C
P
CORPS SYSTEM COMMANDS:
BRIEF - LIST EXPLANATION OF A PROGRAM.
EXECUTE - RUN A CORPS PROGRAM.
LIST - LIST THE AVAILABLE CORPS PROGRAMS.
STOP - EXIT FROM CORPS SYSTEM MACRO.
HELP - HELP AND EXPLANATION OF CORPS SYSTEM
AND THE RUNNING OF THE MACRO.

NOTE:  COMMANDS MAY BE ABBREVIATED TO THE FIRST
       LETTER OF THE COMMAND.

ENTER COMMAND (BRIEF, EXECUTE, LIST, HELP, STOP):
LIST
```

This capability is not yet implemented on the VAX, Apollo, Intergraph, or PC.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM A Three-Dimensional Stability Analysis/Design (3DSAD) Program: General Loads Module (X8100 or X8100E)	PROGRAM NO. 713-F3-R008

PREPARING AGENCY US Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199.

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Fred T. Tracy and Mary Ann Leggett	June 1989	OP	

A. PURPOSE OF PROGRAM

3DSAD performs an overturning and sliding stability analysis for complex three-dimensional (3-D) structures. General shapes and specific structure types can be handled. General modules are geometry, loads, analysis, and free-body. The General Loads Module computes forces and moments for a general 3-D structure from data created by the CDAMS or CLOCKS Modules or by the user.

B. PROGRAM SPECIFICATIONS

FORTRAN

C. METHODS

Loads are computed in the basic version (X8100 on the PC) by giving a direction to a volume defined in General Geometry Module format (pressure volumes) and point loads. The enhanced version (X8100E on the PC) allows simplified loads commands to be used where soil and water levels are specified. This enhanced version also has full color hidden line and continuous tone plotting capability of geometry and loads, while the basic version has the ability to display color wire-frame plots.

D. EQUIPMENT DETAILS

A graphics terminal with a time-sharing system, a stand-alone engineering workstation, or personal computer is necessary. The enhancements discussed above are available only on the Intergraph engineering workstations and the PC, but separate versions are not necessary for the Intergraph engineering workstations.

E. INPUT-OUTPUT

Input is in the form of an interactive session that can be combined with an input file. Output is displayed on the terminal or monitor or sent to a remote plotter or printer.

F. ADDITIONAL REMARKS

This program is available through the CORPS Library for the Honeywell DPS-8, Cybernet CDC, Harris 500, DEC VAX, Apollo and Intergraph engineering workstations, or PC.

WATERWAYS EXPERIMENT STATION REPORTS PUBLISHED UNDER THE COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

	Title	Date
Technical Report K-78-1	List of Computer Programs for Computer-Aided Structural Engineering	Feb 1978
Instruction Report O-79-2	User's Guide: Computer Program with Interactive Graphics for Analysis of Plane Frame Structures (CFRAME)	Mar 1979
Technical Report K-80-1	Survey of Bridge-Oriented Design Software	Jan 1980
Technical Report K-80-2	Evaluation of Computer Programs for the Design/Analysis of Highway and Railway Bridges	Jan 1980
Instruction Report K-80-1	User's Guide: Computer Program for Design/Review of Curvilinear Conduits/Culverts (CURCON)	Feb 1980
Instruction Report K-80-3	A Three-Dimensional Finite Element Data Edit Program	Mar 1980
Instruction Report K-80-4	A Three-Dimensional Stability Analysis/Design Program (3DSAD)	
	Report 1: General Geometry Module	Jun 1980
	Report 3: General Analysis Module (CGAM)	Jun 1982
	Report 4: Special-Purpose Modules for Dams (CDAMS)	Aug 1983
Instruction Report K-80-6	Basic User's Guide: Computer Program for Design and Analysis of Inverted-T Retaining Walls and Floodwalls (TWDA)	Dec 1980
Instruction Report K-80-7	User's Reference Manual: Computer Program for Design and Analysis of Inverted-T Retaining Walls and Floodwalls (TWDA)	Dec 1980
Technical Report K-80-4	Documentation of Finite Element Analyses	
	Report 1: Longview Outlet Works Conduit	Dec 1980
	Report 2: Anchored Wall Monolith, Bay Springs Lock	Dec 1980
Technical Report K-80-5	Basic Pile Group Behavior	Dec 1980
Instruction Report K-81-2	User's Guide: Computer Program for Design and Analysis of Sheet Pile Walls by Classical Methods (CSHTWAL)	
	Report 1: Computational Processes	Feb 1981
	Report 2: Interactive Graphics Options	Mar 1981
Instruction Report K-81-3	Validation Report: Computer Program for Design and Analysis of Inverted-T Retaining Walls and Floodwalls (TWDA)	Feb 1981
Instruction Report K-81-4	User's Guide: Computer Program for Design and Analysis of Cast-in-Place Tunnel Linings (NEWTUN)	Mar 1981
Instruction Report K-81-6	User's Guide: Computer Program for Optimum Nonlinear Dynamic Design of Reinforced Concrete Slabs Under Blast Loading (CBARCS)	Mar 1981
Instruction Report K-81-7	User's Guide: Computer Program for Design or Investigation of Orthogonal Culverts (CORTCUL)	Mar 1981
Instruction Report K-81-9	User's Guide: Computer Program for Three-Dimensional Analysis of Building Systems (CTABS80)	Aug 1981
Technical Report K-81-2	Theoretical Basis for CTABS80: A Computer Program for Three-Dimensional Analysis of Building Systems	Sep 1981
Instruction Report K-82-6	User's Guide: Computer Program for Analysis of Beam-Column Structures with Nonlinear Supports (CBEAMC)	Jun 1982
Instruction Report K-82-7	User's Guide: Computer Program for Bearing Capacity Analysis of Shallow Foundations (CBEAR)	Jun 1982

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WATERWAYS EXPERIMENT STATION REPORTS PUBLISHED UNDER THE COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

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	Title	Date
Instruction Report K-83-1	User's Guide: Computer Program With Interactive Graphics for Analysis of Plane Frame Structures (CFRAME)	Jan 1983
Instruction Report K-83-2	User's Guide: Computer Program for Generation of Engineering Geometry (SKETCH)	Jun 1983
Instruction Report K-83-5	User's Guide: Computer Program to Calculate Shear, Moment, and Thrust (CSMT) from Stress Results of a Two-Dimensional Finite Element Analysis	Jul 1983
Technical Report K-83-1	Basic Pile Group Behavior	Sep 1983
Technical Report K-83-3	Reference Manual: Computer Graphics Program for Generation of Engineering Geometry (SKETCH)	Sep 1983
Technical Report K-83-4	Case Study of Six Major General-Purpose Finite Element Programs	Oct 1983
Instruction Report K-84-2	User's Guide: Computer Program for Optimum Dynamic Design of Nonlinear Metal Plates Under Blast Loading (CSDOOR)	Jan 1984
Instruction Report K-84-7	User's Guide: Computer Program for Determining Induced Stresses and Consolidation Settlements (CSETT)	Aug 1984
Instruction Report K-84-8	Seepage Analysis of Confined Flow Problems by the Method of Fragments (CFRAG)	Sep 1984
Instruction Report K-84-11	User's Guide for Computer Program CGFAG, Concrete General Flexure Analysis with Graphics	Sep 1984
Technical Report K-84-3	Computer-Aided Drafting and Design for Corps Structural Engineers	Oct 1984
Technical Report ATC-86-5	Decision Logic Table Formulation of ACI 318-77, Building Code Requirements for Reinforced Concrete for Automated Constraint Processing, Volumes I and II	Jun 1986
Technical Report ITL-87-2	A Case Committee Study of Finite Element Analysis of Concrete Flat Slabs	Jan 1987
Instruction Report ITL-87-1	User's Guide. Computer Program for Two-Dimensional Analysis of U-Frame Structures (CUFRAM)	Apr 1987
Instruction Report ITL-87-2	User's Guide: For Concrete Strength Investigation and Design (CASTR) in Accordance with ACI 318-83	May 1987
Technical Report ITL-87-6	Finite-Element Method Package for Solving Steady-State Seepage Problems	May 1987
Instruction Report ITL-87-3	User's Guide: A Three Dimensional Stability Analysis/Design Program (3DSAD) Module	Jun 1987
	Report 1: Revision 1: General Geometry	Jun 1987
	Report 2: General Loads Module	Sep 1989
	Report 6: Free-Body Module	Sep 1989
Instruction Report ITL-87-4	User's Guide: 2-D Frame Analysis Link Program (LINK2D)	Jun 1987
Technical Report ITL-87-4	Finite Element Studies of a Horizontally Framed Miter Gate	Aug 1987
	Report 1: Initial and Refined Finite Element Models (Phases A, B, and C), Volumes I and II	

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WATERWAYS EXPERIMENT STATION REPORTS PUBLISHED UNDER THE COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

(Continued)

	Title	Date
Technical Report ITL-87-4	Finite Element Studies of a Horizontally Framed Miter Gate Report 2: Simplified Frame Model (Phase D) Report 3: Alternate Configuration Miter Gate Finite Element Studies—Open Section Report 4: Alternate Configuration Miter Gate Finite Element Studies—Closed Sections Report 5: Alternate Configuration Miter Gate Finite Element Studies—Additional Closed Sections Report 6: Elastic Buckling of Girders in Horizontally Framed Miter Gates Report 7: Application and Summary	Aug 1987
Instruction Report GL-87-1	User's Guide: UTEXAS2 Slope-Stability Package; Volume I, User's Manual	Aug 1987
Instruction Report ITL-87-5	Sliding Stability of Concrete Structures (CSLIDE)	Oct 1987
Instruction Report ITL-87-6	Criteria Specifications for and Validation of a Computer Program for the Design or Investigation of Horizontally Framed Miter Gates (CMITER)	Dec 1987
Technical Report ITL-87-8	Procedure for Static Analysis of Gravity Dams Using the Finite Element Method — Phase Ia	Jan 1988
Instruction Report ITL-88-1	User's Guide: Computer Program for Analysis of Planar Grid Structures (CGRID)	Feb 1988
Technical Report ITL-88-1	Development of Design Formulas for Ribbed Mat Foundations on Expansive Soils	Apr 1988
Technical Report ITL-88-2	User's Guide: Pile Group Graphics Display (CPGG) Post-processor to CPGA Program	Apr 1988
Instruction Report ITL-88-2	User's Guide for Design and Investigation of Horizontally Framed Miter Gates (CMITER)	Jun 1988
Instruction Report ITL-88-4	User's Guide for Revised Computer Program to Calculate Shear, Moment, and Thrust (CSMT)	Sep 1988
Instruction Report GL-87-1	User's Guide: UTEXAS2 Slope-Stability Package; Volume II, Theory	Feb 1989
Technical Report ITL-89-3	User's Guide: Pile Group Analysis (CPGA) Computer Group	Jul 1989
Technical Report ITL-89-4	CBASIN--Structural Design of Saint Anthony Falls Stilling Basins According to Corps of Engineers Criteria for Hydraulic Structures; Computer Program X0098	Aug 1989
Technical Report ITL-89-5	CCHAN--Structural Design of Rectangular Channels According to Corps of Engineers Criteria for Hydraulic Structures; Computer Program X0097	Aug 1989
Technical Report ITL-89-6	The Response-Spectrum Dynamic Analysis of Gravity Dams Using the Finite Element Method; Phase II	Aug 1989
Contract Report ITL-89-1	State of the Art on Expert Systems Applications in Design, Construction, and Maintenance of Structures	Sep 1989